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James Rowland Angell, 1869-1949, Psychologist-Educator

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JAMES ROWLAND ANGELL made substantial and brilliant contributions to the science, education, and culture of his time. What he did and the influence he exerted, not only in the United States but internationally, are part and parcel of our most cherished achievements of the last half-century. He went all out for man. With clear vision, he saw that human progress and development lay along the road of research and cooperation. A master in the scientific study of the mind and of human behavior, he sought by lucid, analytical writing; by entertaining, summarizing addresses; and by wise administrations to realize on the implications of scientific research for the improvement of human living and achievement. He was an opener of the mind's eye. His salty Yankee comment both stimulated and challenged all who heard his dry voice, and left enduring traces in their memories. He never overreached himself; his points and objectives were not hazy or chimerical; his readers and auditors were not left with a flat or helpless feeling, but rather with hope and determination. In several different capacities, he exercised what must be accounted great administrative authority, but he did not push people around, or wave a big stick. He was companion, friend, teacher, and leader, and understood not only human foibles and frailties, but how to energize human capacities, power, and strength.

Jim Angell was born in Burlington, Vermont May 8, 1869, the youngest of three children. His mother, Sarah Swope Caswell, was a descendant of Peregrin White, of Mayflower fame. His brother, Alexis Caswell, twelve years older, became a judge on the federal bench. His sister, Lois Thompson, six years older, became the wife of an historian, Andrew C. McLaughlin. When Jim was born, his father, James Burrill Angell, was president of the University of Vermont. He had formerly been professor of modern languages at Brown University, and editor of the *Providence Journal* for six years. Subsequently he was the distinguished president of the University of Michigan for 38 years. In the latter academic household and community Angell grew up. It is not without interest to note that John Dewey, who greatly influenced Angell's early scientific outlook and professional life, was also born in Burlington, Vermont and was ten years his senior. Choice hereditary and environmental factors were not lacking and there was a virile religious family background. Jim's health was impaired by recurrent attacks of malaria, and by scarlet fever, which produced deafness in one ear. In his home he had a large amount of adult association: with his parents, the academic community, and many distinguished visitors. Among the latter he has recalled Cannon Farrar, Matthew Arnold, Andrew White, and Grover Cleveland. In his biography he says, "I was practically on my own, for my brother and sister were too much my elders to be companions in any intimate sense" (*2*).

After graduating from public school and starting high school in Ann Arbor, he spent a year and one-half in China, where his father had been sent as United States Minister. Jim, having completed high school, entered the University of Michigan and received his B.A. in 1890, and his M.A. in '91. As an undergraduate at Michigan, Angell's intellectual interests seem to have been aroused first by the study of Greek and then more especially by philosophy and psychology. The latter was under John Dewey, who had recently published a psychology text. Williston Hough taught him British philosophy, and with James H. Tufts he studied the general history of philosophy. The climax of his Michigan experience was a seminar with Dewey on William James' recently published *Principles of psychology*. Angell has said that this book, more than any other, profoundly influenced his thinking for the next twenty years of his life.

Fresh from this stimulating graduate year at Michigan, and on the recommendation of Dewey, he went, in the fall of 1891, to the Graduate School at Harvard, and studied under James, Royce, and Palmer. Taught and stimulated by this remarkable faculty, he was yet undecided whether to follow philosophy or psychology. After taking his M.A. at Harvard in '92, he went to Europe, as so many of the brilliant graduate students of his period did. Finding Wundt's laboratory at Leipzig full, he spent his first semester at the University of Berlin, where Ebbinghaus was lecturing on psychology and Paulsen on ethics. Also he occasionally audited the lectures of Helmholtz and other eminent scholars there. The second semester was spent at Halle under Erdmann in psychology and with Vaihinger on the philosophy of Kant. Angell became a candidate for the doctor's degree and wrote a thesis on "The Treatment of Freedom in Kant's *Critique of Pure Reason* Compared with the *Critique of Practical Reason*." His thesis had been accepted and returned for revisions when he received an offer to become instructor in philosophy and psychology at the University of Minnesota. Accepting this offer meant immediate departure for America. Revision of his thesis was consequently put off, and he did not receive his degree from Berlin then or later.

In beginning his work as a teacher, as a laboratory organizer and director, and as a research worker, Angell was singularly fortunate in his choice of positions. Moreover, he entered the field of psychology at its most formative period and when only eight American institutions had ventured to open laboratories. In the period 1890–1892, that is, between his senior year at Michigan and his M.A. at Harvard, twelve new psychological laboratories were started. These included Michigan and Yale, but not Minnesota or Chicago, both of which awaited Angell's advent. His record as a student at Michigan and at Harvard was highly recommendatory to him. He knew, had studied with, and was favorably known by men who were already leaders or later became leaders. The American Psychological Association, organized in 1892, elected him to membership the following year, at the age of 24. His name was starred in the first edition of *American men of science*, 1906, the same year he was president of the American Psychological Association. His reputation as a teacher, as a researcher, and as a research director grew rapidly, on a solid foundation of keen scientific insight and steady, devoted application to work. Frank Angell, the noted older psychologist of Stanford University, was his cousin. And although it may be said that Jim's academic background and connections may have tugged at his bootstraps, he was certainly not lacking in energy, drive, or headwork. He produced abundantly and in good quality, and graduate students were attracted from all over the country.

Only one year was spent in a vigorous workout at Minnesota—arranging and teaching courses, building up a psychological laboratory, and introducing a course in laboratory methods. Students and faculty associates alike were pleased and stimulated by these developments, which were aided materially by the chairman of the Department of Philosophy and Psychology there, Williston Hough, Angell's former Michigan teacher. John Dewey was now head of the Department of Philosophy at the University of Chicago. Angell was offered an assistant professorship there, with the opportunity of taking charge of the laboratory and the courses in psychology. Thus, in 1895 he began his career as psychologist at Chicago, which terminated in the academic year 1918–1919, when he was acting president of that university.

Angell's scientific writings, aside from his unpublished doctoral dissertation, first took the form of critical reviews of scientific literature on memory, thought and imagery, habit and attention. Shortly after his Chicago laboratory was going, however, there began a series of joint publications with his students on experimental studies. These included contributions to such topics as the influence of attention and habit on reaction time, the organic effects of agreeable and disagreeable stimuli, the relations of dermal and optical space, monaural localization of sound, and the relation of organic processes to consciousness (for a bibliography to 1931 see reference *5*). Rooted in laboratory research results and nurtured by discussions with Dewey and others, there gradually grew up in Angell's mind a newly organized scientific outlook for psychology, which came to be known as "functional psychology," in contrast to the "structural" point of view. Angell championed the position that psychology is the science of mental operations rather than the science of mental elements. This position, sometimes designated as the "functional school" (*4*), was clearly foreshadowed in his psychology textbook of 1904, which had the supplementary title, "An Introductory Study of the Structure and Functions of Human Consciousness." His text was very successful and reached a fourth edition in 1908. In his presidential address before the American Psychological Association in 1906 on "The Province of Functional Psychology" he gave this point of view its clearest statement and strongest impetus. The functional formulation was strengthened through interest at the time in the development of educational psychology, experimentation on animals, and the study of intelligence through mental tests.

Angell's efforts to mold psychology into something more respectable and presentable among the sciences, as well as more representative of the range of man's psychological life, were no doubt in part stimulated by his very close association with leading scientists in other fields. Albert Michelson was his warm friend and tennis companion, Jacques Loeb and Henry Donaldson were next-door neighbors. Robert Millikan, Henry Gale, Eliakim Moore, Julius Stieglitz, and George Hale, to mention some who represented the exact sciences, were among his close friends and constant associates. Even Angell's ready and brilliant wit could not wholly satisfy such associations; his science had to be good. It had to be founded on something solid, its experimental and quantitative data demanded integration around an acceptable and practical philosophic viewpoint. Angell was not lacking under this stimulation. He played everything he had and hit the psychological jack pot; many excellent students were attracted to his laboratory, and through them and their successful careers his influence was multiplied.[1]

Throughout the period of his deanships at the University of Chicago, 1908–1919, Angell continued to direct the psychological laboratory and to be productive in psychological writing and editing. He brought out his second volume, *Chapters from modern psychology,* in 1912, remodeled his introductory text in 1913, and again in 1918. He published a considerable number of articles, and contributed chapters. In connection with the American Psychological Association Angell was a leader in standardizing experimental procedures and mental tests and in organizing laboratory courses and apparatus for psychology. He thus played a prominent role both in systematizing the objectives and content of the young science of psychology, and also in organizing its teaching as a laboratory science and promoting its applications in the broad field of American education.

In World War I, Dean Angell participated on a full-time basis with other psychologists in devising and adapting psychological methods to the large task of classification of personnel in the Army. Later he was an advisory member on the Committee on Education and Special Training. At the end of the war he became full-time chairman of the newly organized National Research Council, which he served during the year 1919–1920. The Council, created as an operating agency under the National Academy of Sciences by President Woodrow Wilson, largely took form under the direction of Angell's associate and friend, George E. Hale. For a few months prior to Angell's chairmanship, John C. Merriam, later to become president of the Carnegie Institution of Washington, had served in this capacity.

The quality of Jim Angell's mind, his ability to immerse himself in a large amorphous subject, to sort out its logical relations, to see practical implications, and to present the subject in challenging description and orientation for his fellows is illustrated in his leadership of the National Research Council. Shortly after becoming chairman, he addressed the Twenty-First Annual Conference of the Association of American Universities on the subject, "The Organization of Research" (*1*). In this address, which is one of the most comprehensive and lucid statements of the platform of science, and as applicable now as then, he analyzed the concept of research, and the distribution of research functions. He discussed personnel, training of research men, organization, and cooperation in research, and presented the possibilities opened up through the creation of the National Research Council. Concerning the fundamental nature of research, Angell said: "I would accordingly urge that in our conception of research we look beyond the peculiar combination of intellectual traits, which may characterize any one individual, and think of it as the organized technique of science itself for its own propagation. It is, so to speak, the reproductive process of science. When thus conceived it takes on a far larger and more momentous aspect than when thought of, as too often at present, as being a mere appendix to the processes of science, a sort of luxury of the scientific idle rich."

While Angell was chairman of the National Research Council (1920) he was elected to the National Academy of Sciences. He was the sixth psychologist to be elected to the Academy.[2] His maternal grandfather, Alexis Caswell, mathematician and astronomer and sometime president of Brown University, was one of the fifty charter members. Also during 1920 the Carnegie Corporation made a large gift for the support of the National Academy and the Council and for the erection of a stately building on Constitution Avenue in Washington. In association with Robert Millikan and George Hale, Angell was successful in securing from private sources the considerable fund required to purchase the site where the building now stands. These activities brought him into close touch with Elihu Root and the Board of Trustees of the Carnegie Corporation. Mr. Carnegie had died in 1919, and before and following his death the affairs of the corporation had been under the guidance of a small board of trustees with Mr. Root as chairman. The board now invited Mr. Angell to become president of the corporation. This unprecedented offer, if yielded to, meant severing his connection with university work, and dismissing the attractive and strong probability of his succeeding President Judson at the University of Chicago. It was a difficult decision, but he accepted this newly created and broad executive position—to which, needless to say, he brought large competence and vision.

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[1] In his autobiography (page 38) Angell mentions the following among his women students: Helen Thompson Woolley, June Downey, Florence Richardson Robinson, Kate Gordon, Jessie Allen Charters, Ada Hart Arlitt, Grace and Mabel Fernald, Mary Hayes, Stella B. Vincent, Helen Koch, Jean Weidensall, Dagny Sunne, and Edwina Abbott Cowan. Among his men students he lists: John B. Watson, Joseph, Harvey, and John Peterson, Walter Hunter, Harvey Carr, Beardsley Ruml, Clarence Yoakum, Curt Rosenow, L. L. Thurstone, Joseph Hayes, Myron L. Ashley, Walter V. Bingham, Henry F. Adams, Edward S. Robinson, Harry D. Kitson, Carl Rahn, Conrad L. Kjerstad, Jacob R. Kantor, Louie W. Webb, F. A. C. Perrin, Joseph U. Yarborough, Elmer K. Culler, and Rutledge T. Wiltbank.

[2] Those whose election preceded that of Angell were: James McKeen Cattell (1901), William James (1903), Josiah Royce (1906), John Dewey (1910), and G. Stanley Hall (1915).

These two years in Angell's life—the first as chairman of the National Research Council and the second as president of the Carnegie Corporation—proved to be important for the future of Yale University. They were supertraining and broadening years, which against Mr. Angell's solid scientific and educational background, at the age of 52, prepared him obviously and exceptionally to succeed Arthur Hadley as president of Yale in 1921. Not for a century and a half had Yale chosen a leader outside the frame of its own traditions. In prospect, the "bulwark of tradition" must have looked somewhat ominous, but Mr. Angell won hands down. As an adopted son, or perhaps it was naturalized stepfather, he was readily accepted by students, faculty, and alumni. His sixteen years as president of Yale were effective and brilliant, and constitute a great period in the history of that institution. In his administrative office he had the loyal, devoted, and skillful support of George Day, Thomas Farnam, Robert Hutchins, Carl Lohmann, Wilbur Cross, and Charles Seymour, as top team. The combination was good. Developments too numerous to mention took place; the educational climate of the country was ready for them and was improved by them. Mr. Angell was successful in convincing the Yale alumni that the university's acceptance of the munificent gift of Edward S. Harkness for the establishment of the residential college system constituted a great step forward. The adoption of "the College Plan" will always be remembered as one of the notable achievements of his administration. It was on February 22, 1930 that Mr. Angell announced the adoption of the residential college system at Yale and the appointment of the first master in the person of Robert D. French. Another accomplishment which should also never be forgotten was the success of the movement, initiated at Angell's urging, for the enlargement of the university's endowment. Carried forward under his enthusiastic leadership, the campaign resulted in obtaining the then incredibly large sum of twenty million dollars for the making "of a finer, not a bigger Yale." To this project over 22,000 of Yale's friends pledged support in one year.

In 1937 no one was concerned that Mr. Angell at retirement would be lacking employment. What overtures or offers he received are not publicly known. But that he became educational counselor for the National Broadcasting Company is no secret. What he did in this new educational position as a kind of presiding judge over the content broadcast by radio waves around the globe, and what influence this may have had on man and his destiny only The Almighty knows. That his counsel was sought and valued and acted upon in an ultramodern institution staffed by brilliant, imaginative young men, who chose and accepted him as a colleague in their great exploratory enterprise, must have given him deep satisfaction.

The term "emeritus" never fitted well in Angell's case, except perhaps on the page of a college catalog. From the age of 45 or 50 to the very end of his gallant life, in New Haven on March 4, 1949, he was in constant demand to serve on committees, commissions, and boards of directors, and as a speaker on all sorts of select occasions. He could shift the mood of an audience as easily and as nonchalantly as he changed his spectacles but he never let them leave without some new and important mental imprint. Numerous published addresses reveal President Angell's qualities of mind and something of his charming personality, but unfortunately they seldom include many of the humorous asides that so characteristically accompanied his associations and appearances. Scores of these are treasured memories, as for example, when after walking in the rain in the procession at the Harvard Tercentenary, he said: "This is one of the ways in which Harvard soaks the rich." His type and his order of achievement appear rarely in any generation. Science and education in its forward progress will look back to him with admiration and affection.

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Smear Preparations for the Electron Microscopy of Animal Chromosomes[1]

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An essential requirement for an electron microscope preparation is that it pass the test of light microscopy: its structure should appear at least as well preserved as the best conventional preparations for cytological study. The most useful procedure for the analysis of chromosome structure in the light microscope has been the so-called squash or smear technique. The squashing or smearing of cells between slide and cover slip is used to break the nucleus, thus setting the chromosomes free for study, and furnishing specimens with regions that are stretched so thin that details of the internal structure can be looked for. Until the present work, no successful routine had been developed by which the smear technique could be adapted to furnish electron microscope preparations.

Methods previously employed for the electron microscope study of chromosomes include isolation of the individual chromosomes by microdissection (*1, 3–5*); the preparation and isolation of chromatin threads by differential centrifugation of disrupted nuclei (*6*); and the cutting of very thin sections of embedded tissue (*4, 8*).

The procedure to be described here is an adaptation of the standard cytological smear technique, and provides preparations suitable for study in both light and electron microscopes.

1. *Primary fixation and squash.* The first step in the procedure is carried out as for conventional light microscopy. In making good squash preparations one must fix the material rapidly enough to preserve structure, without hardening it so much that it cannot be stretched. A fixative-stain containing 2 percent orcein and 60 percent acetic acid is satisfactory for both types of cell studied here, *Drosophila* salivary gland cells and the spermatocytes of man. The material can be dissected either in the appropriate Ringer's solution, or in the fixative-stain. In either case, dissection should be followed by about ten minutes in the fixative-stain, to a fresh drop of which the material is then transferred. A clean cover slip is mounted over it, held at one side with a piece of blotting paper, and tapped with a needle under the dissecting microscope, first to spread the cells into a single layer, then more forcibly to break the nuclei. They are then compressed still further by rolling the thumb, with maximum force, over a fresh piece of blotting paper placed upon the cover slip to remove excess fluid from the preparation.

2. *Transfer to formvar film.* The preparation is frozen over a block of dry ice, after which the cover slip can be pried off with a chilled razor blade. Part of the material then adheres to the slide and part to the cover slip. On the desired part of the preparation is then placed a drop of 95 percent glycerine and 5 percent saturated aqueous solution of lanthanum acetate. The lanthanum acts as an additional fixative, important for preserving the structure through the later treatments, and possibly serves as an electron stain for the nucleic acids.

A slide or cover slip previously coated with a formvar film approximately 200 A thick is quickly placed over the cellular material. Inserted into the jaws of a vise, the preparation is pressed firmly against the film, but not so forcibly as to smash the chromosomes. The preparations are now examined under the light microscope, and failures are discarded.

Slide and cover slip together are now placed in a Coplin jar containing a third fixative, a solution of three parts saturated picric acid, and one part formalin (40 percent formaldehyde). After six to twelve hours in this solution, the slide and cover slip will have separated, leaving some of the chromosomes attached to the formvar film.

3. *Dehydration.* The preparation on the film is now rinsed in distilled water and carried through the usual series of increasing concentrations of alcohol,

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[1] Aided by an institutional grant from the American Cancer Society to The Institute for Cancer Research, and by Contract N6-ori-168 Task Order II between the Navy Department and the Trustees of the University of Pennsylvania.

[2] Present address, Army Medical Department Research and Graduate School, Army Medical Center, Washington 12, D. C.

FIG. 1

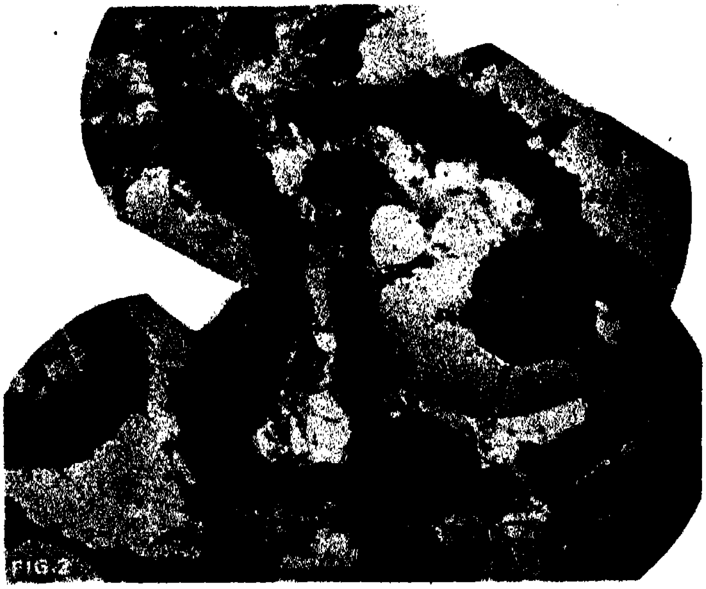

FIG. 2

FIG. 3

and finally through two changes of absolute alcohol. Following this, it is placed in a 0.5 percent solution of collodion in absolute alcohol for ten minutes. On removal, the preparation is allowed to dry in air and, being imbedded in collodion, suffers little or no distortion.

Extractable collodion is then removed with absolute alcohol, two changes of two hours each. The preparation can now be dried once more, without visible damage to the structure.

4. *Selection of region for study.* The preparation is ready for an exploratory examination under the high dry objective. The region found appropriate for study is cut around with a dissecting needle and teased up to permit a drop of water to flow under the plastic film (9), the drop being confined by a ring drawn with a wax pencil. The supporting grid for use in the electron microscope is then slipped under the film and the water is drawn off with a piece of blotting paper. A small amount of detergent in the water facilitates wetting the grid.

5. *Examination under oil immersion* (*light microscope*). The dried preparation, screen and all, may now be immersed in oil—cedar oil, for example—so that favorable regions can be studied and photographed under optimal conditions for light microscopy. By gentle washing in chloroform, the oil may be removed from the specimen, which is then ready for study in the electron microscope.

An example of the results obtained by our procedure is shown in Fig. 1. It is a light microscope photograph of part of a larval salivary gland nucleus of *Drosophila melanogaster*. Larvae from homozygous Oregon R stock were used, containing mutants *gt* and w^a. We have identified the chromosome regions according to the maps of Bridges (2). Sections 44 to 59 of chromosome 2R are outlined by the rectangle of the figure. Unidentified portions of chromosomes X and 2L can also be seen. In Fig. 2, a montage of a series of electron micrographs of this same section is shown. It is distorted somewhat by breaking of the formvar film. It is clear that the bands of the light microscope map, corresponding to the Feulgen-positive, ultraviolet-absorbing regions shown to be nucleoprotein in character, are also the regions of greatest density to the electron beam.

FIG. 4.

In Fig. 3, a higher magnification shows fine structures. The bands are seen to be composed of a multitude of particles like those seen in the thin sections of Pease and Baker (*8*), and in the replica preparations of Palay and Claude (*7*) demonstrated in a lecture at the University of Pennsylvania. Pease and Baker have made a somewhat detailed discussion of the fine structure of their preparations. Our results, so far as they go, are not in contradiction to theirs. However, it is too early to give support to their suggestion that the character of a band is determined by the size and shape of the individual particulate bodies of which it is composed.

The less dense interband regions show varying numbers of fibrils extending from one band to the next. On these fibrils small globules can be seen, sometimes regularly, sometimes irregularly spaced on adjacent fibrils. The irregularities are perhaps due to unequal stretching. If the globular particles represent types of bands, they would be below the limits of resolution of the light microscope. The fibrils that carry the globules have roughly the same diameter within one interband space. The larger fibrils may, however, be aggregates of smaller ones, some of which are just resolved. It would be premature to discuss the relation of these fibrils to theories of the structure of the giant chromosomes.

Fig. 4 shows an electron micrograph of a similarly prepared human pachytene chromosome, from the same type of material as that used in the study of the nucleolar chromosome of man by Schultz and St. Lawrence (*10*). Here also the alteration of density, corresponding to chromomere and interchromomeric regions, can be seen. The picture corresponds quite well to the studies in similar stages in *Lilium* (Elvers) and *Zea* (Buchholz). In the present micrographs it is possible to see a fine structure of fibrils in the interchromomeric regions (interbands).

The identification of genes with definite areas of the chromosomes of *Drosophila* was made possible as the result of a correlated study of the genetics and cytology of chromosome rearrangements. With the present technique, it is evident that the study can be extended to the electron microscope, and a basis laid for a discussion of the relation of the ultrastructure of the chromosomes to the genes. Similarly, as in human material, where chromomeres are at the limit of resolution of the light microscope, the use of the electron microscope is essential to further progress in mapping chromosomes.

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TECHNICAL PAPERS

Absorption of Radioactive Phosphorus by Mycorrhizal Roots of Pine[1]

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It has been demonstrated that under certain conditions, especially when growing in infertile soil, tree seedlings bearing mycorrhizal roots grow better than those which do not possess mycorrhizae. The improved growth apparently results from greater absorption of mineral nutrients. Routien and Dawson (*3*), for example, found that seedlings of *Pinus echinata* possessing mycorrhizae absorbed more calcium, magnesium, iron, and potassium than seedlings lacking mycorrhizae, and McComb and Griffith (*2*) found the same to be true of certain other species of conifers with respect to phosphorus. Hatch (*1*) attributed most of the beneficial effect of mycorrhizae to the increased absorbing surface, but others (*2, 3*) believed the higher metabolic activity of mycorrhizal roots to be the cause of their greater intake of minerals.

Apparently no direct measurements of mineral absorption by mycorrhizal roots have been made, the conclusions concerning their high efficiency as absorbing structures being based on differences in growth and in chemical composition of plants possessing them as compared with plants lacking them. By immersing roots in radioactive phosphorus and preparing radioautographs it is possible to obtain direct evidence concerning the relative amounts of phosphorus absorbed by various root regions. This method was used to compare the amounts of phosphorus accumulated in mycorrhizal and nonmycorrhizal roots of pine seedlings. The species used were loblolly pine (*Pinus taeda* L.) and red pine (*P. resinosa* Ait.).

Pieces of root 10 to 15 cm in length obtained from potted pine seedlings were carefully washed in distilled water, and gently freed of bits of soil and other foreign matter with a camel's hair brush. P^{32}, essentially carrier-free, was obtained in acid solution and was diluted with distilled water to the desired activity which varied from 100–500 μc 1 in various experiments. The pH of the solution was adjusted to about 5.5 with NaOH. Roots were exposed for 3 or 4 hr to the radioactive solution in shallow dishes to insure adequate aeration. They were then rinsed in distilled water for 30 sec, in 0.001N H_3PO_4 for 10 sec, and again rinsed in distilled water for 30 sec. The acid rinse was used to aid in freeing the surfaces of the roots from adsorbed radioactive phosphorus by exchange. The washed roots were blotted and dried between glass plates. Medium lantern slides were then placed with emulsion side toward the roots, but separated from them by sheets of aluminum foil, 0.01 mm thick, for periods ranging from a few hours to 3 days, depending on the activity of the roots.

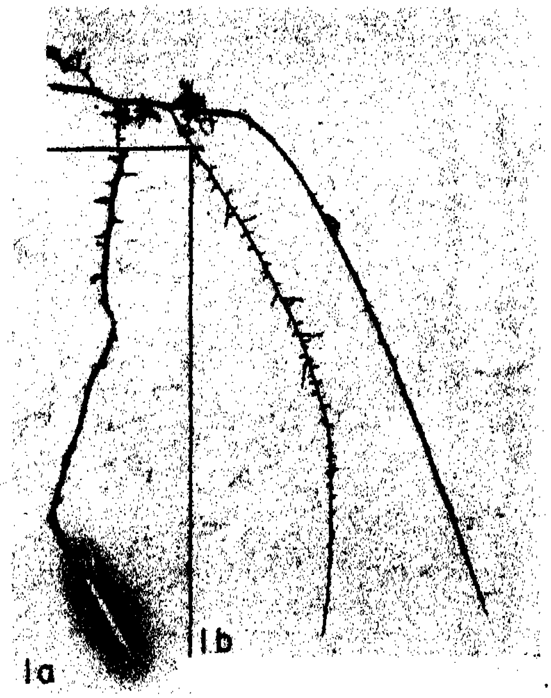

FIG. 1. Photographs (actual size) of portions of roots of red pine seedlings grown in soil, showing unsuberized (lower portion of each root) and suberized regions, mycorrhizal clusters (upper portion of 1b), and short branches. Many of the latter appear to be pseudomycorrhizal or nonmycorrhizal.

Photographs of typical roots of red pine are shown in Fig. 1, a and b, and their radioautographs in Fig. 2, a and b. These roots were cut into 1-cm segments and the activity of each segment was measured with a Geiger-Müller counter. The relative activity of each segment is indicated on the autographs.

As would be expected, there is less phosphorus accumulated in the completely suberized portions of the main roots than in the unsuberized region near the root tips. This is apparent in Fig. 2a and the left hand root of Fig. 2b. The right hand root in Fig. 2b is less mature and the numerous branches are scarcely visible. The coralloid clusters of mycorrhizal roots (upper portion of Fig. 2b) show the largest accumulation, supporting the common belief that they are actively involved in nutrient intake. Perhaps even more interesting is the relatively great accumulation of radioactive phosphorus by the short branch roots, even by those which show none of the hypertrophy or dichotomous branching characteristic of typical mycorrhizae. Some of these branch roots resemble those pictured by Hatch (*1*) in his Plate III, A, B, and F, and in Plate XIII, B, and described as nonmycorrhizal or pseudomycorrhizal roots. These he believed to be of negligible importance in the absorption of nutrients. Although these roots appeared to be suberized almost to their tips and therefore had a very limited absorbing surface we found that they accumulated surprisingly large amounts of phosphorus. Measurements of radioactivity indicated that the tips of the main roots did not contain as much radioactive phosphorus as the older portions bearing branches. A heavily suberized root bearing a few short branches or a small cluster of mycorrhizal roots apparently can absorb more phosphorus than an unbranched tip with a much larger unsuberized surface.

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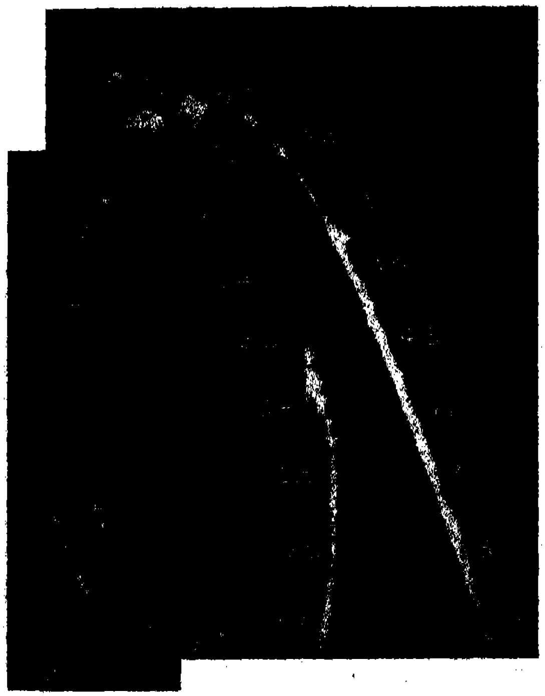

FIG. 2. Radioautographs of the roots pictured in Fig. 1. The numbers indicate relative radioactivity of 1-cm segments as measured by a Geiger counter.

In a few instances autographs indicated that completely suberized roots absorbed considerable phosphorus, but microscopic examination of such roots showed that they were covered with a superficial layer of mycelium which apparently has a very large capacity to accumulate phosphorus. The few mycorrhizal branches which failed to show accumulation were dark and wrinkled, and apparently dead. A few unsuberized root tips showed very low accumulation of phosphorus, indicating that not all unsuberized root surfaces are equally active in absorption of solutes.

It appears possible that the increased accumulation of phosphorus by mycorrhizal roots may not result only from increased surface but perhaps may be related to a greater capacity for absorption because of high metabolic activity. Routien and Dawson found the oxygen consumption of mycorrhizal roots to be two to four times that of nonmycorrhizal roots. In preliminary experiments we have found that 10^{-3} M sodium azide, which may be expected to inhibit oxygen consumption, reduces the accumulation of P^{32} by both mycorrhizal and nonmycorrhizal roots. Study of the effect of respiration inhibitors was complicated by variations in proportion of mycorrhizal to nonmycorrhizal tissue in root samples, making quantitative comparisons difficult.

The results of these experiments show that mycorrhizal portions of roots of pine can accumulate much larger quantities of phosphorus than nonmycorrhizal portions. Root segments bearing short, unbranched, pseudomycorrhizal lateral roots appear to accumulate more phosphorus than typical unsuberized root tips. It seems possible that mycorrhizal roots have not only a greater surface, but also a greater capacity to accumulate phosphorus per unit of surface than nonmycorrhizal roots. Apparently in pine roots the region of maximum intake of minerals is not the root tips, as in roots of herbaceous plants, but the older regions where mycorrhizal or pseudomycorrhizal branch roots have developed.

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A Qualitative Analysis of the Amino Acids in Royal Jelly[1]

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Royal jelly, a secretion of the pharyngeal glands of the young worker of the honey bee, *Apis mellifera* L. (*6*), is the sole food of bee larvae which develop into sexually mature female adults, or queens. Larvae which develop into sexually immature female adults, or workers, are fed royal jelly for 2 days, then receive a mixture of pollen and honey during the remainder of their 5-to-6-day feeding period (*9*). Research toward an explanation of the role of royal jelly in the development of castes of *Apis mellifera* L. has been reviewed by Haydak (*6*).

Chemical analyses of royal jelly have shown that it is a complex mixture of substances having a protein content of 9 to 18% of the fresh material (*6*). The proteins were found by Abbott and French (*1*) to consist of an albumin and probably a globulin in the ratio of 2 to 1. Aeppler (*2*) by unstated methods and Townsend and Lucas (*10*) by chemical methods identified 7 amino acids in the hydrolyzed proteins of royal jelly (Table 1), but did not investigate the possibility of the occurrence of free amino acids in this substance. During the course of research on free amino acids in the blood of insects, an analysis of both free and combined amino acids in royal jelly was undertaken. Separation and identification of amino compounds was accomplished by the paper chromatographic method of Consden, Gordon, and Martin (*5*).

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Approximately 0.5 ml of fresh royal jelly was suspended in 1 ml of distilled water and diluted with 10 ml of 95% ethyl alcohol in order to precipitate the proteins. The precipitated proteins were separated by centrifugation, and the supernatant, which contained free amino acids, was drawn off. The proteins were washed with 1-ml aliquots of 95% alcohol until a negative ninhydrin reaction was obtained in the washings. The solution was evaporated to dryness by means of a jet of air and the residue dissolved in 300 µl of distilled water. Aliquots of 50, 100, and 150 µl were chromatographed.

TABLE 1

FREE AND COMBINED AMINO ACIDS OF ROYAL JELLY

Amino acid or derivative	As free compound	As protein constituent
Alanine	+	+
Arginine	+	+*
Aspartic acid	+	+*
Cystine	–	+*
Glutamic acid	+	+
Glycine	+	+
Histidine	–	–*
Hydroxyproline	–	–
Isoleucine and/or Leucine	+	+
Lysine	+	+*
Methionine	+	+
Phenylalanine	–	+
Proline	+	+
Serine	+	+
Threonine	–	+
Tyrosine	+	+*
Tryptophane	–	–*
Valine	+	+
β-Alanine	+	
Glutamine	+	
Taurine	+	
Unknown	+	

* Previously reported (*2, 10*)

The precipitated proteins were divided into two portions, one of which was hydrolyzed with 5 N NaOH and the other with 6 N H_2SO_4. Hydrolysis was accomplished by autoclaving for 12 hr at 15-lb pressure. The hydrolyzates were neutralized, then evaporated to 0.5 ml by means of an air jet and gentle heating. Aliquots of 50 and 100 µl were chromatographed.

It is evident from the data in Table 1 that significant quantities of amino acids and amino acid derivatives occur in the free state in royal jelly. The presence of cystine, histidine, hydroxyproline, phenylalanine, threonine, and tryptophane was not demonstrated. It is possible that extraction of amino acids from a larger sample of royal jelly would demonstrate the presence of histidine, for it is the least sensitive of the amino acids to identification by paper chromatography (*8*). Assuming complete extraction of free amino acids from the sample of royal jelly, an estimation based on the volume of aliquots chromatographed and on sensitivities of various amino acids to the method (*8*) indicates that, if amino acids not found in the free state do occur as such, they are present in less than the following quantities per ml of fresh royal jelly: cystine 0.032 mg, histidine 0.1 mg, hydroxyproline 0.004 mg, phenylalanine 0.02 mg, threonine 0.008 mg, tryptophane 0.008 mg.

Hydroxyproline, histidine, and tryptophane were not identified in hydrolyzed proteins of royal jelly. The latter two compounds were found in hydrolyzed proteins of royal jelly by Aeppler (*2*) and by Townsend and Lucas (*10*). Further research is needed to clarify this discrepancy.

The size and color intensities of proline spots occurring on chromatograms of free amino acids were greater than those occurring on protein chromatograms, indicating relatively large quantities of free proline in royal jelly. Auclair and Jamieson (*3*) have shown that pollen (dandelion, willow, and mixed taken from a beehive; and dandelion collected from blooms) is rich in free proline, which may explain its abundance in royal jelly since young worker bees consume pollen during their period of secretion of royal jelly.

The presence of free taurine in royal jelly is of interest. This compound, which is formed from cysteine in the animal body and is a constituent of the bile salts of animals, is known to occur in large quantities in muscle tissue of invertebrates, but its function there is unknown (*4*). Free taurine has also been found in blood of honey bee larvae and of two other adult insect species (*7*).

An amino compound of unknown composition was isolated as a free constituent of royal jelly. It has also been found free in the blood of honey bee larvae (*7*) and in pollen (*3*). Comparison of its chromatographic position with those of several known amino compounds has thus far failed to identify this interesting compound.

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The Effect of 7-Ketocholesterol on the Rabbit

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Wintersteiner and Bergstrom found that a stream of air passed through a colloidal solution of cholesterol resulted in the production of principally 7-ketocholesterol and 7-hydroxycholesterol (*10*). Kendall, Meyer, and Bevans (*6*) reported that single intravenous injections into rabbits of such oxidized solutions produced lipid droplets within the cells of the intima in 24 hr. Multiple intravenous injections led to an immediate increase of sudanophilic material in the intima, which roughly paralleled the amount of oxidized material injected. In control experiments of these workers, early changes did not result from the administration of unoxidized cholesterol. However, if high plasma cholesterol levels were maintained for several weeks by repeated injections of either unoxidized or oxidized material, there was little difference in the extent or character of the lesions produced.

7-Ketocholesterol was prepared by us according to the method of Windaus, Lettre, and Schenk (*9*). Altschul (*1*) found that when this compound was given to rabbits either orally (in capsules of 0.3 g daily) or percutaneously, as a solution in benzene and vegetable oil (approximately 0.1 g daily), it produced none of the cellular reactions characteristic of the administration of pure cholesterol. However, 7-ketocholesterol administered orally or percutaneously had a definite effect on the liver. Examination showed atrophy of the liver cords and the presence of necrotic areas, numerous giant cells, and an overgrowth of connective tissue and biliary epithelium. In two instances, this organ showed a characteristic "hobnail" surface.

Thus the pathological changes brought about with 7-ketocholesterol did not parallel those found by Kendall *et al.*, using colloidal solutions of cholesterol oxidized according to Wintersteiner and Bergstrom, and therefore presumed to contain chiefly 7-ketocholesterol and 7-hydroxycholesterol. This difference in pathological findings suggested that the effect of administering a mixture of α and β epimers of 7-hydroxycholesterol should be studied, and this is at present under investigation. Also of possible significance is the observation that, under optimum conditions for oxidation, these colloidal solutions contained about 20% unchanged cholesterol (*10*).

Collier and Cox have found that percutaneous administration of approximately 0.1 g of 7-ketocholesterol daily for 64 days resulted in a greatly increased sterol concentration (calculated as cholesterol) in the plasma, as detected by a modification of the Tshugaev reaction (*8*). However, examination of plasma from an animal which received orally 0.3 g of 7-ketocholesterol daily for 40 days showed a comparatively normal sterol level. The plasma of both animals contained only a trace of 7-ketocholesterol, when determined by the micromethod of these workers (*2*). The possibility that liver selectively reduces 7-ketocholesterol to cholesterol, or to a sterol giving a color reaction similar to that of cholesterol when determined by the zinc chloride-acetyl chloride reagent, is now being examined. Of interest in this investigation is the observation that the epimeric 7-hydroxycholesterols, which can be prepared by the selective reduction of the keto group in 7-ketocholesterol (*9*), have been isolated from ox liver in recent years (*3, 4, 7*). However, it is not known whether these hydroxycholesterols are true intermediates in sterol metabolism, or only autoxidation products of cholesterol, perhaps formed during the process of extraction (*5, 11*).

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Survey of Chinese Drugs for Presence of Antibacterial Substances[1]

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In view of recent studies on the production of antibiotic substances by higher plants (*1–6*), it seems interesting to make a survey of drugs commonly used in the practice of Chinese medicine for the presence of antibacterial substances. The so-called Chinese drugs are actually roots, stems, seeds, leaves, or flowers of various higher plants in a very dehydrated state (prepared by special methods). This paper reports the results of such a survey.

To 10–20 g of a drug cut in small pieces, 150 ml of distilled water was added, and the mixture was then boiled slowly for 2–3 hr or longer to a final volume of about 25 ml. (This is the customary way of preparing Chinese medicine, except that ordinary tap water is used instead of distilled water.) After preliminary filtering, the filtrate, which is really a concentrated water extract

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[1] This work was carried out in 1945 before departure of the authors for the United States. Since the return of the senior author to China in 1947, some of the experiments were repeated and extended.

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TABLE 1

ANTIBACTERIAL ACTION OF CHINESE DRUGS*

Name of drug	Identified scientific name	*Staph. aureus*	*E. coli*
Ma Huang	*Ephedra sinica* Stapf. (stem)	0	0
Ma Tou Ling	*Aristolochia debilis* S. et Z. (fruit)	0	0
Si Sin	*Asarum sieboldii* Miq. (root)	0	[illegible]
Ta Huang	*Rheum palmatum* L. (or *R. officinale* Baillon) (root)	28–35	+
Peh Tou Ung	*Anemone chinensis* Bunge (root)	0	0
Mao Ken	*Ranunculus pensylvanicus* L. (leaf and fruit)	0	8–10
Huang Lien	*Coptis chinensis* Franch (stem and root)	17–20	0
Lien Chiao	*Forsythia suspensa* Vahl. (fruit)	0	0
Kou Teng	*Strychnos panicula* Champ. (stem)	0	0
Chang San	*Dichroa febrifuga* Lour. (root and leaf)	0	+
Hai Tung Pi	*Erythrina* sp. (bark)	16–21	0
Tu Chung	*Eucommia* sp. *ulmoides* Oliv. (bark)	0	0
Chai Hu	*Bupleurum falcatum* L. (root, stem, and leaf)	+	0
Ku Tsan	*Sophora flavescens* Ait. (var. Galegoides Hemsl.) (root)	0	0
Keh Ken	*Pueraria Thunbergiana* Benth. (root)	0	0
Tsao Chieh Chieh	*Gleditschia sinensis* Lam. (stem)	0	+
Huang Peh	*Phellodendron chinense* Schneid. (bark)	0	+
Ku Lien Tzu	*Melia Azedarach* L. (fruit)	+	0
Yuan Chih	*Polygala sibirica* L. (root and leaf)	0	+
Ta Chih	*Euphorbia pekinensis* Rupr. (root)	0	0
Pa Tou	*Croton Tiglium* L. (seed)	0	0
Ta Fung Tzu	?	0	0
Shih Chun Tzu	*Quisqualis indica* L. (fruit)	0	0
Peh Chih	*Angelica sp.* (root)	0	0
Fang Fung	*Siler divaricatum* B. et H. (root)	0	0
She Chuang Tzu	*Selinum Monnieri* L. (seed)	0	0
Shan Shu Yu	*Cornus officinalis* S. et Z. (fruit)	18–24	0
Shih Nan	*Rhododendron indicum* Sweet (leaf)	+	0
Chai Tsao	*Lithospermum officinale* L. (root)	0	0
Poh Ho	*Mentha arvensis* L. (stem and leaf)	0	0
Ti Kuh Pi	*Lycium chinense* Mill. (bark and root)	0	0
Ti Huang	*Rehmannia glutinosa* Libosch (root)	0	0
Chu Tsien	*Plantago major* L. (stem and leaf)	0	0
Tsien Tsao	*Rubia cordifolia* L. (root)	10–14	0
Jen Tung Teng	*Lonicera japonica* Thunb. (vine)	0	0
Chieh Keng	*Platycodon grandiflorum* DC. (root)	0	0
Tsang Muh	*Atractylis ovata* Thunb. (root)	+	+
Kuan Tung	*Tussilago Farfara* L. (flower)	0	0
Pu Kung Ing	*Taraxacum mongolicum* Hand.-Mazz (leaf, stem, and root)	0	0
Niu Pang	*Arctium Lappa* L. (seed)	0	0
Chi Hsueh Teng	*Tripterygium Wilfordii* Hook. f. (vine)	12–16	0
Cheh Sieh	*Alisma plantago* L. (root)	0	0
Pan Hsia	*Pinellia ternata* Breit. (root)	0	0
Peh Pu	*Stemona sessilifolia* Miq. (or *S. japonica* Miq.) (root)	0	10–12
Chih Mou	*Anemarrhena asphodeloides* Bunge (root)	+	0

* 0 = no activity + = very slight inhibition
Numerals indicate size of inhibition zone in mm

of the drug, was made bacteria-free by passing through a Mandler diatomaceous filter candle at 8-lb pressure, and then was tested against *Staphylococcus aureus* and *Escherichia coli.* (Both cultures were supplied by the Department of Bacteriology, School of Medicine, National Central University.) No attempt was made to make any of the assays quantitative. The test plates were prepared as follows: bacterial cultures were grown for 24 hr in nutrient broth and 1-ml portions of these suspensions were plated in 1.5% nutrient agar. Porcelain Peni-cylinders were affixed to the surface of these plates immediately after hardening of the agar and filled with the drug extract to be tested. The plates were incubated at 37° C for 18–24 hr. The diameters of the inhibition zones were measured and recorded in mm. Results of the test are given in the table.

From Table 1 it can be seen that six of the drugs, namely: Ta Huang (*Rheum palmatum* L. or *R. officinale* Baillon), Huang Lien (*Coptis chinensis* Franch), Hai Tung Pi (*Erythrina* sp.), Shan Shu Yu (*Cornus officinalis* S. et Z.), Tsien Tsao (*Rubia cordifolia* L. and Chi Hsueh Teng (*Tripterygium Wilfordii* Hook. f.) showed various degrees of antibacterial activity for *Staphylococcus aureus,* while two others; Mao Ken (*Ranunculus pensylvanicus* L.) and Peh Pu (*Stemona sessilifolia* Miq. or *S. japonica* Miq.) showed antibacterial activity (of relatively low potency) for *Escherichia coli.*

The eight drugs that showed bacterial inhibition were tested for their effect on the respiration of the respective bacteria and their toxicity to animal tissues. The effect on respiration was measured by using the Warburg type of microrespirometer and it was found that none of the drugs has any effect on bacterial respirations although bacterial multiplication was checked, indicating that the drugs are bacteriostatic in action. The toxicity was tested on living human leucocytes, following the general procedures used by the Oxford workers (6). The leucocytes continued to move for about 2–4 hr after the drug extracts were added. They are, therefore, nontoxic, which is to be expected, as prepared medicine is always administered orally in the practice of Chinese medicine.

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The Harefoot Mushroom, *Coprinus lagopus* Fr., on Fruits Used Commercially as Seedstocks[1]

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Sporophores of the black-spored mushroom, *Coprinus lagopus* Fr., have developed saprophytically from fruits of several plants during germination testing of the enclosed seeds. They have been observed frequently on fruits of European-grown New Zealand spinach since 1940 and occasionally on seedballs (botanical fruits) of garden beets. The pileus of a sporophore was small in proportion to the stipe, 4 to 28 mm across, tender, at first cylindrical, covered with fugacious fibrils, at maturity becoming campanulate, then flattened, smooth, with edges revolute or split. A mature, fully elongated stipe was typically long, slender, hollow, fragile, and bulbous, 5 to 26 cm high, 2 to 7 mm in diameter, white and wooly. The gills were white when young, then black, free, remote, linear, and very thin. The spores were black, elliptical, easily visible through the thin flesh of the pileus, and averaged 11.7 to 13.1 × 6.3 to 7.4 μ.

The sporophores occurred singly, scattered, or in crowded clumps, of 20 to 30 on a fruit, seedball, or other nonliving structure enclosing the true seeds. The first sporophores of *Coprinus lagopus* usually matured in about 24 days after the infested fruits had been placed in a germinator operated at an alternating temperature of 20° and 30° C. During ripening, the stipes of the mushroom elongated rapidly, the pilei became flattened, and the gills deliquesced completely within a few hours. When removed from a humid germinator to the more arid laboratory, young sporophores arising from any medium invariably withered and failed to mature.

As previously suggested (*5*), the mushroom was recognized as *Coprinus lagopus* Fr. According to Saccardo (*7*), the spore sizes of this species are 12 to 13 × 6 to 8 μ, while the pileus is tender, 2 to 3 cm long, and the stipe is fragile. Rea's (*6*) description of *C. lagopus* is applicable, except in spore measurements of 10 to 12 × 6 to 7 μ, to the specimens observed at Geneva. Kaufman (*3*), in classifying 30 species of *Coprinus* of Michigan, included no specific description of *C. lagopus* but did state that *C. tomentosus* Fr. may be the *C. lagopus* of various authors. The mushrooms observed on fruits at Geneva, and at State College, New Mexico clearly did not conform to Kaufman's (*3*) description of *C. tomentosus*, although the spore sizes were parallel.

Previously Rea (*6*) and Pape (*4*) have identified agarics found on seedballs of beets and mangels as *Coprinus pilosus* Beck. and *C. nycthemerus* Fr. respectively. A few specimens growing on fruits of New Zealand spinach and seedballs of beets at Geneva might have been recognized as one of these species had not continued culturing produced the typically long-stemmed fruit bodies of *C. lagopus*. It is probable that both Rea and Pape would have assigned the beet-infesting mushroom to *C. lagopus* had they transferred their cultures to richer media.

Successful transferring of both the beet and New Zealand spinach strains to manure, rotten wood, and straw has shown that the size of the sporophore is somewhat dependent upon the medium. The transfers also furnished proof that the strains isolated at Geneva readily grow on the same media, manure and rotten wood, mentioned by Rea (*6*) and Pape (*4*) for English and German strains.

Since the first observation of *Coprinus lagopus* upon European-grown fruits of New Zealand spinach, the mushroom has fruited on garden beet seedballs, on the berry-like fruits or arils of yew (*Taxus cuspidata capitata* Sieb & Zacc.), on the calyx and bracts surrounding seeds of pincushion flower (*Scabiosa caucasica* Bieb.), and on glumes enclosing caryopses of bluestem wheatgrass (*Agropyron smithii* Rydb.), and of crested wheatgrass (*A. cristatum* Gaertn.). The sporophores of a *Coprinus* were previously (*1*) reported from the fruit or lomentum of sainfoin, *Onobrychis viciaefolia* Scop.

Fruit bodies of the larger species of *Coprinus* commonly collected for food have never developed from any commercial seedstock tested at Geneva. Attempts to establish these species in fruits of New Zealand spinach and in seedballs of garden beets have been entirely unsuccessful.

Apparently the mycelium of *Coprinus lagopus* was borne within the fruits, seedballs, glumes, or similar plant parts. Fungus hyphae have been demonstrated in those tissues from which sporophores developed. Furthermore, surface sterilization of New Zealand spinach fruits and of beet seedballs did not inhibit development of the sporophores of *C. lagopus*. The hyphae have not been demonstrated in the botanical seeds enclosed in fungus-infested fruits, and sporophores have never arisen from the seeds of any species.

Spores of *Coprinus lagopus* have not been found on seeds, fruits, or other plant structures received for routine germination testing. In fact, no evidence has been found to indicate that spores do, or even could, perpetuate the fungus.

The medium, whether a seed-enclosing structure or disorganized tissue, visibly affects the size of the fruit bodies. The stipes arising from glumes enclosing seeds of *Agropyron* spp. both at State College, New Mexico, and at Geneva were only 2 to 5 cm high, with pilei of 7 to 12 mm diameter. With successive transfers to blotting paper, New Zealand spinach fruits, and beet seedballs, the fruit bodies progressively increased in size. The larger stipes from the latter medium averaged 14 cm in length while the ripened pilei averaged 26 mm in diameter.

The size of the sporophore had only slight influence or none upon the size of the spores. The averages of 12 to 13 μ × 6 to 8 μ as specified by Saccardo (*7*) were applicable to spores dropping from 95% of the sporophores. The kind and size of fruit or similar plant part, while affecting the size of the sporophores, did not exert a similar influence upon the spores. The size of the spores remained very constant when a strain of *Coprinus lagopus* from *Agropyron smithii* was successively cultured on glumes of *A. cristatum*, seedballs of beets, and fruits of New Zealand spinach.

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The size of the sporophores, the constancy of spore measurements, the ease of transfer of the fungus from fruits of one plant species to those of others, and the failure of the large edible species to grow upon fruits indicate that the harefoot mushroom is the species of *Coprinus* that has been observed at Geneva, New York, and at State College, New Mexico.

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The Validity of the Use of Tracers to Follow Chemical Reactions

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In the use of tracers, either stable or radioactive, it is important to know how much difference in chemical properties there is between the isotopic molecules. The thermodynamic properties of systems containing isotopic molecules in chemical equilibrium can be calculated by simple formulae (*1*).

Recently Urey (*4*) tabulated the equilibrium constants of various exchange reactions for isotopic compounds of elements in the first row of the periodic table, as well as the halogens. In many cases the isotopic molecules are not in equilibrium with respect to various exchange reactions. In such cases it is important to know whether or not the specific activity of the product of some chemical transformation of the substrate isotopic molecules is the same as the initial specific activity. If the initial specific activity is known, then the specific activity of the product can be calculated by integration of the rate equations for the respective reactions. In this paper we shall neglect changes in the specific activity by radioactive decay or other nuclear processes. These corrections can be made by the use of the equations of radioactive transformation (*3*).

We shall consider the general case where the isotopic molecules A_1 and A_2 react either with each other or with other molecular species B, C, etc. to give the isotopic molecules X_1 and X_2 amongst the products. Frequently the isotopic molecule A_2 may be a mixed molecule and contain two different isotopes of one element in chemically equivalent positions, e.g., CH_3D. A mixed molecule may react in one of two ways. It may give the products X_3, Y, etc. or X_2, Y_2, etc. In most cases X_3 will be the same as X_1 but we shall retain the symbol X_3 to avoid confusion. If the isotopic molecule A_2 is present only in tracer amounts, then the reaction will always be first order in A_2. If a_1^0 and a_2^0 are the initial concentrations of A_1 and A_2 respectively, then the amounts of X_1, X_2 and X_3, dx_1, dx_2 and dx_3 respectively, formed in a time interval dt at the time t by reaction according to the following equations

$$A_1 + B + C + \ldots \xrightarrow{k_1} X_1 + Y_1 + \ldots \qquad (1)$$

$$A_2 + B + C + \ldots \xrightarrow{k_2} X_2 + Y_1 + \ldots \qquad (2)$$

$$A_2 + B + C + \ldots \xrightarrow{k_3} X_3 + Y_2 + \ldots \qquad (3)$$

are

$$dX_1 = k_1(a_1^0 - lX_1)^n (B)^b (C)^c \ldots dt \qquad (4)$$

$$dX_2 = k_2(a_2)(a_1^0 - lX_1)^{n-1} (B)^b (C)^c \ldots dt \qquad (5)$$

$$dX_3 = k_3(a_2)(a_1^0 - lX_1)^{n-1} (B)^b (C)^c \ldots dt \qquad (6)$$

where $a_2 = a_2^0 - mX_2 - nX_3.$

The coefficients l, m, and n are small numbers which are derived from the stoichiometry of the reaction.

From equations (5) and (6) it follows that

$$dX_3 = (k_3/k_2)\,dX_2 \qquad (7)$$

and

$$X_3 = (k_3/k_2)\,X_2 \qquad (8)$$

Thus

$$a_2 = a_2^0 - (m + nk_3/k_2)\,X_2 \qquad (9)$$

From equations (4), (5), and (9) we get

$$\frac{k_2}{k_1}\int_0^{x_1} \frac{dX_1}{(a_1^0 - lX_1)} = \int_0^{x_2} \frac{dX_2}{a_2^0 - (m + nk_3/k_2)\,X_2} \qquad (10)$$

Integration of equation (10) gives

$$\frac{X_2}{a_2^0} = \frac{1 - (1 - lX_1/a_1^0)^{k_2(m+nk_3/k_2)/k_1 l}}{m + nk_3/k_2} \qquad (11)$$

If we define the specific activity of the product as $N_x = X_2/X_1$ and the initial specific activity as $N_{A^0} = a_2^0/a_1^0$, then

$$\frac{N_X}{N_{A^0}} = \frac{1 - (1 - lX_1/a_1^0)^{k_2(m+nk_3/k_2)/k_1 l}}{(m + nk_3/k_2)\,X_1/a_1^0} \qquad (12)$$

For small amounts of conversion, $lX_1/a_1 << 1$,

$$\frac{N_X}{N_{A^0}} = k_2/k_1 \qquad (13)$$

At complete conversion, $X_1 = a_1/l$,

$$\frac{N_X}{N_{A^0}} = \frac{l}{m + nk_3/k_2} \qquad (14)$$

In a forthcoming publication from this laboratory (*2*) a general equation is derived for the ratio of the rate constants for reactions involving isotopic molecules. For reactions which occur at room temperature and above, the ratio of the rate constants can be expressed approximately by the equation

$$\frac{k_1 s_1 \ddagger s_2}{k_2 s_2 \ddagger s_1} = \left(\frac{m_2^*}{m_1^*}\right)^{1/2} \Big(1 + \sum_i^{3n-6} G(u_i)\Delta u_i - \sum_i^{3n^1-6} G(u_i\ddagger)\Delta u_i\ddagger\Big) \qquad (15)$$

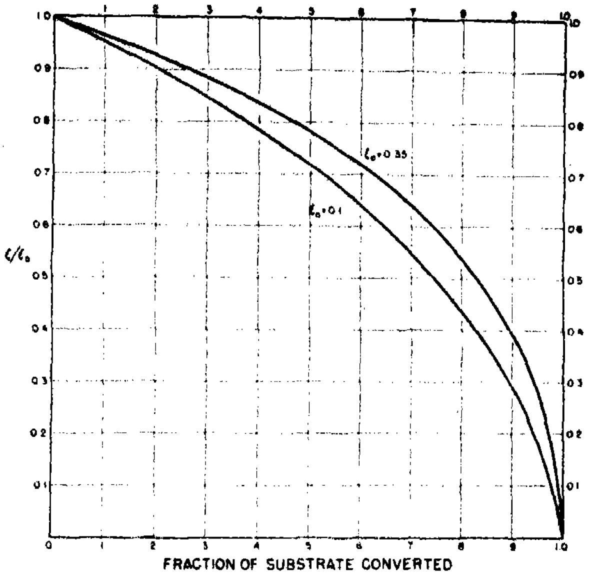

FIG. 1. Isotope effect in a chemical reaction involving isotopic molecules reacting with nonidentical rate constants vs. amount of reaction.

where the subscripts 1 and 2 refer to the light and heavy isotopic molecules respectively. A similar equation holds for the ratio k_3/k_3. The righthand side of equation (15) gives the amount that a simple statistical consideration must be corrected by. The symbol ‡ refers to a property of the activated complex in the reaction. The quantity s is the symmetry number; m^* is the effective mass of the activated complex along the reaction coordinate; $G\ (u)$ is a function of the normal vibrations of the molecule (*1*); $\Delta u_i = \frac{hc}{kT}\ (\omega_{i_1} - \omega_{i_2})$ where ω_i is a normal frequency of the molecule.

It is important to see how the specific activity of the product, N_X, compares with the initial specific activity, N_{A_0}, as a function of the amount of reaction. We shall consider the special case, which is one of wide generality, where $k_3 = 0$, and l, m, and the ratio $s_1{\ddagger}s_2/s_2{\ddagger}s_1$, are each unity. We shall now define ε and ε_0 by the relations

$$\frac{N_X}{N_{A_0}} = 1 - \varepsilon \qquad (16)$$

$$\frac{k_2}{k_1} = 1 - \varepsilon_0 \qquad (17)$$

In Fig. 1 curves are drawn for $\varepsilon/\varepsilon_0$ as a function of the amount of reaction for two values of ε_0. It is clear that for complete conversion of the substrate, $X_1/a_1 = 1$, $\varepsilon = 0$. This holds independently of the value of ε_0. For $\varepsilon_0 = 0.35$ the specific activity of the product is 4% different from the initial specific activity, even at 99% conversion.

We shall show presently that apart from the isotopes of hydrogen, the values of ε_0 are *usually* so small that there is little error made by assuming that it is zero. By comparison of equations (15) and (17) it is seen that ε_0 is equal to the deviation of the reciprocal of the righthand side of equation (15) from unity. The function $G\ (u_i)$ as well as Δu_i is always positive (*1*). $G\ (u_i) = \frac{1}{2} - \frac{1}{u_i} + \frac{1}{e^{u_i} - 1}$ and its value will fall between 0 and 1/2. Thus the maximum value of the ratio $k_1 s_1{\ddagger}s_2/k_2 s_2{\ddagger}s_1$ will occur when $\Sigma_i\ G\ (u_i{\ddagger})\ \Delta u_i{\ddagger}$ is equal to zero. This corresponds to the physical situation where the isotopic atoms are essentially free, unbound chemically, in their respective activated complexes. The values of $\Sigma_i\ G\ (u_i)\ \Delta u_i$ for a considerable number of isotopic molecules of the light elements have been tabulated (*4*). It is not difficult to calculate additional values for other elements. Thus we can arrive at estimates for upper limits of the ratio of the rate constants for reactions involving many of the common tracers. These are tabulated in Table 1.

It is clear that the maximum isotope effects in the rates of reaction decrease rapidly as one goes to isotopic compounds of higher atomic number. Of the common tracers, H^2, H^3, C^{13}, and C^{14}, may require special consideration in their use in nonequilibrium systems. There are very few reactions of carbon compounds in which the activated complex contains even loosely bound carbon atoms. In fact, $\Sigma_i\ G\ (u_i{\ddagger})\ \Delta u_i{\ddagger}$ will usually be approximately equal to $\Sigma_i\ G\ (u_i)\ \Delta u_i$. If we define $\varepsilon_0{}^1$ by the relation

$$k_1 s_1{\ddagger}s_2/k_2 s_2{\ddagger}s_1 = 1 + \varepsilon_0{}^1 \qquad (18)$$

we may anticipate that in any reaction involving C^{13} or C^{14} the values of $\varepsilon_0{}^1$ will not be greater than .12 and .25 respectively at room temperature. In any case the contribution of $\left(\frac{m_2}{m_1}\right)^{1/2}$ to $\varepsilon_0{}^1$ can usually be calculated and $\varepsilon_0{}^1$ can be approximated by setting $\Sigma_i\ G\ (u_i)\ \Delta u_i = \Sigma_i{}^1\ G\ (u_i{\ddagger})\ \Delta u{\ddagger}$. This amounts to calculating the relative collision frequencies of gases. If an accuracy of this order of magnitude will suffice, then it is safe to assume that C^{13} and C^{14} are faithful tracers in both equilibrium

TABLE 1

ESTIMATED MAXIMUM RATIOS IN SPECIFIC RATE CONSTANTS AT 25° C

Stable isotope	Tracer isotope	$k_1 s_2 s_1{\ddagger}/k_2 s_1 s_2{\ddagger}$
H^1	H^2	18
H^1	H^3	60
Li^6	Li^7	1.1
Be^9	Be^7	1.15
Be^9	Be^{10}	1.08
B^{10}	B^{11}	1.3
C^{12}	C^{13}	1.25
C^{12}	C^{14}	1.5
N^{14}	N^{15}	1.14
N^{14}	N^{16}	1.14
N^{14}	N^{13}	1.25
O^{16}	O^{18}	1.19
F^{19}	F^{18}	1.25
N^{23}	Na^{22}	1.08
N^{23}	Na^{24}	1.08
Mg^{24}	Mg^{27}	1.08
P^{31}	P^{32}	1.02
S^{32}	S^{35}	1.05
Cl^{35} (natural abundance)	Cl^{36}	1.03
Cl^{37} (natural abundance)	Cl^{38}	1.14
Ca^{40}	Ca^{45}	1.08
I^{127}	I^{131}	1.02

and nonequilibrium systems. In quantitative work it will be necessary to determine ε_0^1 experimentally or to estimate it theoretically. In many experiments an appreciable fraction of the substrate is allowed to react. From equation (12) and Fig. 1 it is obvious that the isotope effect decreases with the amount of reaction and thus the isotope effects in the use of C^{13} and C^{14} will be even smaller than .12 and .25 respectively.

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Shielding of Syringes Used for Injecting Radioactive Solutions[1]

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The delayed general effects of total body radiation, intermittant, subclinical, and of no apparent immediate significance, have had serious consequences for some radiologists and radium therapists (*3, 5*). The introduction of radioisotope therapy offers additional sources of exposure to these persons since they are, in general, best trained to handle the new tools. Similarly, lesions appearing on the hands of some radiologists later in life indicate the latent effects of localized ionizing radiations (*2, 4*).

During an investigation of the biological significance of radiogallium (Ga^{72}), it was found that for protection against the strong gamma spectrum (2.5 mev) of this isotope some type of remote central apparatus or some dense shield over a standard syringe was necessary. Because of the difficulty of using a remote control injection apparatus clinically, there have been designed and constructed two types of shields to be placed over syringes of standard stock sizes.

Fig. 1 presents details of construction of a two-piece Lucite shield adequate to protect the hands of persons injecting alpha emitters and beta emitters having energies less than 2 mev. This type of shield offers protection against the following isotopes: C^{11}, C^{14}, F^{18}, P^{32}, S^{35}, Cu^{64}, and Sr^{89}. It is emphasized that the isotopes listed here emit no gamma radiation. For those which do, the metal shield described in Fig. 2 must be used.

The design of the Lucite shield (Fig. 1) is similar to that described by Anthony and Norris (*1*), the essential difference being in arrangment for locking the needle in place by tightening the threaded top. This prevents loosening of the needle and subsequent leakage, which is a serious hazard when very active or long half-life isotopes are being injected.

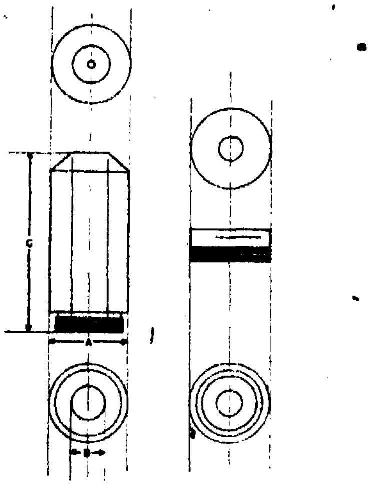

Fig. 1. Plastic syringe holder.

Dimensions:		A	B	C
Size	$\frac{1}{4}$ cc.	$1\frac{1}{2}$ in.	$\frac{5.5}{16}$ in.	$3\frac{11}{16}$ in.
"	1 "	1 "	$\frac{5}{8}$ "	$2\frac{15}{16}$ "
"	5 "	$1\frac{3}{16}$ "	$\frac{10.5}{16}$ "	4 "

Fig. 2 presents details of a metal syringe shield which has been constructed in sizes to fit all standard syringes from 1/4 cc to 30 cc. This piece of apparatus is made by filling an aluminum tube with a commercially available lead alloy (type metal—82 Pb, 12 Sb, 4 Sn), and machining to the dimensions shown in Fig. 2. The slot, which is milled in the metal case, permits observation of liquid levels, absence of air bubbles, etc. To facilitate these observations, a dark colored solution is preferable, and the inside surface of the shield is coated either with

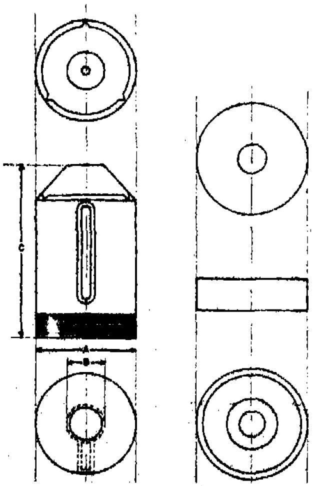

Fig. 2. Metal (Pb) syringe holder.

Dimensions:		A	B	C
Size	$\frac{1}{4}$ cc.	$1\frac{1}{2}$ in.	$\frac{5}{16}$ in.	$3\frac{1}{4}$ in.
"	1 "	$1\frac{1}{2}$ "	$\frac{5}{8}$ "	$4\frac{9}{16}$ "
"	5 "	2 "	$\frac{3}{4}$ "	$3\frac{3}{4}$ "
"	10 "	2 "	$\frac{7}{8}$ "	$4\frac{3}{4}$ "
"	20 "	$2\frac{1}{2}$ "	1 "	$5\frac{1}{2}$ "
"	30 "	3 "	$1\frac{1}{4}$ "	$6\frac{3}{4}$ "

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[1] The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

a phosphor activated by radioactive emanations or by some luminous dial paint.

These shields have been used when studying the biological effects of radiogallium (Ga^{72}) which has an unusually energetic spectrum (β 3.1 mev, γ 2.5 mev). Persons wearing film badges and pocket electroscopes on the body and on the hands have received less than 20 milliroentgens (mr) total body radiation and less than 40 mr on the hands, when injecting solutions of 0.4 mc/ml activity, in quantities up to 4 mc per injection and a total of 25 mc.

The difficulties encountered in using shields of the types described are those of manipulation, due to their size and weight, particularly of the metal shields.

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Erroneous Ascorbic Acid Values Resulting from Interference by Anthocyanins

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The determination of ascorbic acid in anthocyanin-containing plant products presents special problems. If the usual indophenol dye reduction methods are used, the color due to anthocyanin is very similar to that of the dye in acid extracts. In highly colored extracts, it then becomes desirable to eliminate this color. This is easily accomplished by a xylene extraction of the excess dye following the reaction of the dye with ascorbic acid (*1, 2, 5*). Anthocyanins are not extracted by xylene under these conditions. This procedure has been used in the analysis of colored plant materials (*3, 5*).

We attempted to use a xylene extraction method (*2*) for determining the ascorbic acid content of red beets. As previous workers had reported, it was found that the anthocyanin, betanin, was not extracted by xylene and hence did not interfere with the determination due to its color *per se*. However, analytical difficulties of another sort were encountered. It was found, for example, that aliquots of a single metaphosphoric acid extract of beet hypocotyl did not check if the aliquots were of different sizes. Also, similar metaphosphoric acid extracts containing different amounts of tissue per unit volume failed to give comparable results. When aliquots of such extracts were treated with formaldehyde (*6*), the capacity to reduce the dye was decreased to only about one-half its original value. Ascorbic acid is rendered nonreactive under these conditions, and in the absence of interfering substances formaldehyde-treated aliquots no longer reduce the indophenol dye. Hence, it was concluded that these extracts contained appreciable quantities of reducing substance (or substances) other than ascorbic acid. It was observed that this residual reducing capacity was closely correlated with the color of the metaphosphoric acid extracts (coefficient of correlation = + 0.724, $n = 81$).

These observations led to an investigation of the extent of similar interference in other anthocyanin-containing products. In fresh fruits the amount of interference was found to be small; but in a number of fruits stored for months at 0° F, during which time the ascorbic acid largely disappeared, the amount of interference became relatively important.

In order to determine whether or not anthocyanins were the cause of the interference, an attempt was made to isolate various anthocyanins in more or less pure form and to study their reaction with the indophenol dye. It was found that betanin could be obtained in a somewhat concentrated form as follows: Fresh beets were sliced and frozen and the juice was pressed out; this juice was frozen and dried *in vacuo*. When the resulting powder was suspended in water and adjusted to about pH 3.5, the anthocyanin was precipitated by adding ethyl alcohol to give a concentration of about 80%. The precipitate was washed with 95% ethanol and then with acetone by centrifuging, and dried *in vacuo*. The resulting red powder was readily soluble in water and it reacted with the indophenol dye in much the same way as the interfering material present in extracts from fresh beets. Its reaction was not prevented by formaldehyde. Betanin isolated according to the procedure of Pucher *et al.* (*4*) reacted in a similar manner. Thus, it appears evident that the interfering material in extracts from fresh beets is the anthocyanin, betanin.

In view of these results, it seemed desirable to determine the antiscorbutic activity of the concentrated anthocyanin by means of a bioassay. Betanin was prepared from lyophilized beet juice by alcoholic precipitation as outlined above. This material was then assayed chemically and was fed to guinea pigs at the rate of 4 mg daily of apparent ascorbic acid (chemical assay) per animal. The bioassay selected was the depletion technique as used by Tressler, Mack, and King (*7*). From the results obtained it was concluded that the anthocyanin concentrate had no antiscorbutic activity for the guinea pig.

These results will be reported in greater detail elsewhere.

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Effect of Rutin on the Biological Potency of Vitamin C

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The biological potency of vitamin C in different natural sources has only recently become known, and subsequent findings require explanation. Work carried out in this laboratory has shown that the ascorbic acid of certain foodstuffs has a higher apparent biological value, at the lower levels of vitamin intake, than is shown by chemical assay. We have demonstrated in the case of fortified tomato juice and fortified orange juice, and with stored cabbage and dehydrated potato, that chemical methods of assay underestimated the biological potencies, as determined by the odontoblast method of assay. This evidence appears to support the hypothesis that a factor in natural vitamin C carriers increases the biological value of ascorbic acid beyond that expected from chemical analysis.

In the quest of this unknown factor, all evidence pointed to a substance with vitamin P activity. Griffith, Couch, and Lindauer (*2*) fed rutin, a flavonal glycoside, to 14 patients with hypertension, all of whom subsequently showed increased resistance in the capillary walls. This work was confirmed by Shanno (*3*). Ambrose and DeEds (*1*) administered rutin to rabbits, and found that it decreased cutaneous capillary permeability. Furthermore, Wilson, Mortarotti, and DeEds (*4*) showed that rutin prolongs the action of epinephrine on intestinal strips, the prolongation presumably being due to a protection of the epinephrine from oxidative destruction. Based on this information, we postulated that rutin might be one factor responsible for enhancing the biological potency of ascorbic acid in certain natural sources of the vitamin.

This note is a preliminary summary of an experiment carried out in this laboratory to ascertain the biological value of vitamin C in two natural sources of the vitamin, and to test the effect of added rutin on the apparent vitamin C potency of these substances, as well as on synthetic ascorbic acid. The assay included 96 guinea pigs, divided into three equal groups, each group containing equal numbers of both sexes. As the only source of vitamin C, the first or control group received crystalline ascorbic acid, the second group received canned orange-grapefruit juice, and the third group received dehydrated potato. Each assay material was fed at four different levels of vitamin C content, these levels being 0.5; 0.79, 1.26, and 2.00 mg of ascorbic acid per day. The amounts of orange-grapefruit juice and dehydrated potato to be fed were based on chemical analyses of samples of the two materials. Half the animals on each assay material were fed orally 100 mg per day of crystalline rutin.

Using the odontoblast method of assay, it was found that the rutin treatment gave significantly higher values on the response-dose curve at the 0.5, 0.79, and 1.26 mg levels of vitamin C intake for both the synthetic ascorbic acid and orange-grapefruit juice assays (Fig. 1). At the lower levels of vitamin intake, it appears that rutin either makes more available or delays *in vivo* destruction of ascorbic acid in the original source. A further distinct possibility is that rutin forms the basis for synthesis by the animals of additional ascorbic acid. This postulation follows from the similarity between the glucose-fructose side chain of the rutin molecule, and the actual structure of some of the many forms of ascorbic acid. Therefore, rutin, present in some natural vitamin C sources, might be considered to be the factor responsible for enhancing the apparent biological potency of vitamin C.

Because of the very low vitamin C content of dehydrated potato, it was impossible to get the animals, even by forced feeding, to consume enough of this material to meet the necessary levels of ascórbic acid. This resulted in the death of approximately half of these animals due to advanced stages of scurvy with ultimate starvation. Since the intake of dehydrated potato was inadequate and inconsistent, the variability of the results obtained with the survivors was very high. For this reason it was thought inadvisable to include quantitative data on these findings in this report, although the effect of rutin was again apparently to raise the biological potency of vitamin C in the dehydrated potato.

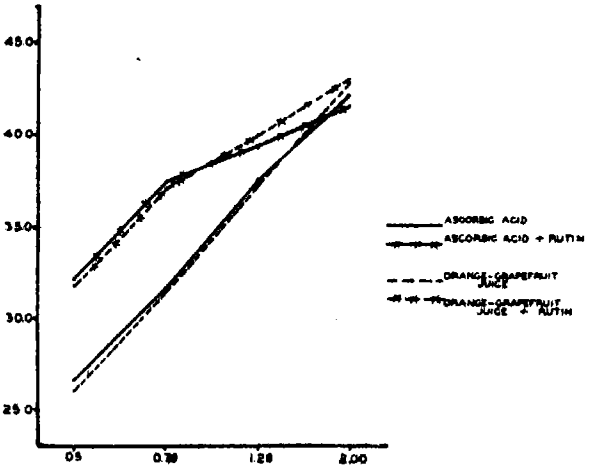

FIG. 1. Effect of supplementary rutin on the response of guinea pigs to increasing doses of vitamin C. Abscissas represent mg ascorbic acid/pig/day; ordinates represent odontoblast height in microns.

It may be tentatively concluded that the enhanced biological value of vitamin C observed in this test is due to the flavonal glycoside, rutin. However, the mechanism of action of rutin is as yet undetermined.

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Preparation and Properties of Tridecanoic Acid Containing C^{14} in the Carboxyl Group

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An organic electrolyte containing a radioactive isotope was required in order to carry out studies of mobilities and molecular sizes of ion-forming compounds in dielectric liquid (*2*), particularly insulating oils. A previous paper (*3*) indicated that any aliphatic acid having a molecular weight equal to or greater than that of propionic acid is suitable for obtaining the electrical conductivity necessary. The further requirement of low vapor pressure, to minimize contamination of the laboratory atmosphere with radioactive vapor, limited the range to acids of molecular weight greater than that of capric acid. Consideration of these requirements of the compound, the means of preparing it, and the available starting materials led to the selection of tridecanoic acid containing C^{14} in the carboxyl group.

The tridecanoic acid was prepared from lauryl bromide and carbon dioxide by the Grignard reaction, the carbon dioxide being obtained by acidification of barium carbonate containing C^{14}. Unlike the usual carbonation of Grignard reagents, this reaction necessitated the use of an excess of Grignard reagent rather than an excess of carbon dioxide, because of the expense of the radioactive isotope used. Since the use of excess Grignard reagent favors the formation of secondary products, such as ketones and alcohols (*4*), the carbonation and subsequent hydrolysis were carried out as rapidly as possible.

Purification from secondary products was carried out by saponification and reprecipitation of the acid.

The purified acid crystallized as white plates, having a melting point of 39.5° to 41.5° C. This compares with 40.5° C found by Krafft (*5*), 40° C by Blau (*1*), and 42.5° C by Le Sueur (*6*). The refractive index was found to be 1.427 n_D at 60° C, which is in close agreement with the value of 1.4249 n_D at 70° C obtained by Waterman and Bertram (*9*). Values of 72.8% carbon and 12.4% hydrogen were obtained by ultimate analysis. These values approximate the theoretical values of 72.8% carbon and 12.2% hydrogen.

The apparatus used for the carbonization of the Grignard reagent consisted of a generating flask, drying tube, and reaction flask, interconnected in the order named. The generating flask contained barium carbonate (0.024 mole) having 2 mc of C^{14}. The radioactive barium carbonate was purchased from the United States Atomic Energy Commission. The drying tube contained anhydrous calcium chloride and the reaction flask contained the Grignard reagent prepared from lauryl bromide. This system was evacuated prior to the carbonation so that a partial vacuum would exist in the apparatus throughout the synthesis, thus preventing the leakage of radioactive vapors into the laboratory atmosphere.

Carbon dioxide was generated from the barium carbonate at such a rate as to keep gas pressure in the system constant at slightly below atmospheric pressure. It was passed through the drying tube into the reaction flask as it was generated and, upon completion of the acidification of the barium carbonate, the carbon dioxide remaining in the system was flushed into the reaction flask with small charges of dry nitrogen until the system had reached atmospheric pressure. The contents of the reaction flask were then hydrolyzed in the usual manner on crushed ice.

The entire reaction from the beginning of the carbonation to the completion of the hydrolysis was carried out within 5 min.

One gram of the product was melted and spread over an area of 20 cm^2, then permitted to crystallize, yielding a layer of about 0.05 cm in thickness. An open area of 4.7 cm^2 was screened out for a count test with a Geiger-Müller counter having a mica window 2.54 cm in diameter and 2.8 mg/cm^2 in thickness. The distance between the sample and the mica window was 9.1 cm. The net counts obtained were 28/sec.

In order to compare this figure with the theoretically expected count, the latter was computed in the following manner. The upward activity I of a layer of thickness ρ g/cm^2, an area of A cm^2, and containing σ mc/g, corresponds to

$$I = \frac{A\sigma}{2\mu}\left(1 - e^{-\mu\rho}\right)$$

where μ = absorption coefficient in cm^2/g of the radiation in question (*7*). If ρ equals or is larger than the range of the betas, the exponential term becomes zero and the bracket is unity. This was the case in this test, since the range of 0.14-Mev betas is 20 mg/cm^2.

From the chemical synthesis, 2 mc of C^{14} should be present in about 0.024 mole of tridecanoic acid, i.e., in 5.2 g of the acid. In other words, $\sigma = 0.39$ mc/g. With $\mu = 270$ cm^2/g for the electrons of radioactive carbon (*8*), we have $I = 0.0034$ mc, or, converted into counts, 1.25×10^5 counts per sec.

From the geometry of the arrangement, the spatial angle (in terms of 2π) that the mica window represents in $1 - \cos \tan^{-1}(1.27/9.1) = 0.0097$. Hence the counts corresponding to this spatial angle are 1200 per sec.

The mass of air between the sample and the counter is 10.9 mg/cm^2, to which must be added the mass of the mica window, giving 13.7 mg/cm^2. The relative intensity of betas escaping absorption is then $\exp(-270 \times 13.7 \times 10^{-3}) = 0.024$. The number of betas that should reach the counter is then 29 per sec. This is in good agreement with the experimentally obtained value of 28 per sec.

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Book Reviews

Cancer: radiations, virus, environment. (Vol. II.) J. Maisin. Paris, France: Casterman, 1949. Pp. 306. 120 fr.

Volume II, comprising Chapters V to VII of Dr. Maisin's treatise on cancer, is a critical review of the literature on the relationship of radiations, viruses, and environment to cancer.

The importance, in the etiology of cancer, of various agents, such as X-rays, radioactive substances, ultraviolet light, certain animal parasites, coal tar, and some hydrocarbons which produce prolonged or chronic irritation is now generally recognized. Cutaneous contact with solar rays or X-rays causes cancer of the skin. Inhalation of radioactive substances causes cancer of the lung. Ingestion of radioactive substances causes cancer of the bone. These phenomena belong to the category of environmental cancer. Dr. Maisin believes that cancerization by these rays, whether internal or external, is the result of mutation of normal cells into neoplastic cells. Another characteristic property of all the cancers caused by radiation is a long period of latency. In man, this period is from 10 to 20 years (from the last irradiation to the onset of the cancer). It seems, therefore, that the cell which has undergone mutation rests dormant for years without division. The altered gene, one could call a mutagene. The atomic bombs that wiped out the cities of Hiroshima and Nagasaki in 1945, although they spared a certain number of humans, different species of animals, and numerous plants, have tragically placed these survivors under ideal experimental conditions for the study of the mutagenic action of penetrating rays. All have been largely irradiated with sublethal doses of α, β, and γ rays. It will be of great value to observe what becomes of their descendants. The accident having occurred, it will be a pity if science cannot profit from it.

It is now well recognized that cancer in animals can be caused by parasites *Gongylonema neoplasticum*, and *Cysticercus fasciolaris*, and by viruses—Rous chicken sarcoma, Fujinami fowl myxosarcoma, Shope rabbit papilloma, Lucké frog kidney carcinoma, Bittner mouse breast cancer, and Yoshida rat ascites sarcoma. (YOSHIDA, T., MUTO Y., and SASAKI Z. *Proc. imp. Acad., Tokyo*, 1944, *20*, 611. Note by K. Sugiura.) However, there is no evidence that cancer in man is caused by parasites or viruses, although this assertion has been made frequently. Carcinogenic parasites or viruses themselves would not be able to initiate a malignant tumor if the environment and genetic factors of the host were not favorable.

Although cancer is not properly termed an hereditary sickness, heredity plays an important role in the genesis of cancer. In certain types of cancer, hormone influence also plays a role in the formation of malignancy. Without this hormonal influence, in spite of heredity, these cancers will not appear. The influence of external environment in the development of human cancer has long been recognized. Percival Pott, in 1775, noted that cancer of the scrotum was unusually common among chimney sweeps. Subsequently, various environmental or occupational cancers have been described. Thus cancer of the skin, lung, and bone by contact with radioactive substances and X-rays; cancer of the scrotum, face, hands, bladder, and liver by contact or ingestion of hydrocarbons; and skin cancer by solar rays. Thus a number of human cancers are known to be of extrinsic origin, but a substantial proportion can be prevented by environmental control in industry.

Finally, Dr. Maisin hopes for discovery of a "penicillin or sulfonamide" for cancer cells. He thinks, however, that the discovery of a carcinolytic substance is further off than the means for the ultimate prevention of cancer.

Dr. Maisin deserves to be congratulated for this valuable addition to cancer literature, and students of cancer may greatly profit from it. The bibliography includes 739 papers, written by 626 individuals and joint authors. The first four chapters, treating the subject of heredity, hormones, and carcinogenic substances, form Volume I of this work.

KANEMATSU SUGIURA
Sloan-Kettering Institute for Cancer Research

Human ancestry from a genetical point of view. R. Ruggles Gates. Cambridge, Mass.: Harvard Univ. Press, 1948. Pp. xvi + 422. (Illustrated.) $7.50.

Nowadays a book on human evolution has a definite reader appeal. This fact imposes on the author a demand for a generally high level of performance—quite apart from his obligation to anthropology, to the reader, and to clear, simple writing. We have every right to expect authoritative reporting and objective interpretation. There are certain descriptive facts concerning fossil man and modern races that are the common possession of the literature in this field and these can be brought together with reasonable facility. It is not so much, therefore, the assembling as the interpreting that becomes important.

Human ancestry does not fulfill this demand. It is unevenly written; one has the feeling that it was written in spurts, with parts, or even whole chapters, inserted as afterthought. Well-established evolutionary concepts are presented almost as though they were unique to the present volume. For example, much is made of "parallel evolution" as a relatively neglected avenue of interpretation; yet Le Gros Clark for the Primates and Olson for the mammals have developed this theme in precise detail.

The lay reader will be dismayed by the interjection into an acceptable literary style of very technical botanical and zoological material as evidence to support sweeping generalizations. The result is rather like encountering a number of road repair and detour signs along a fine concrete highway.

Prof. Gates insists that there are five species of living *Homo*: *H. australicus*, *H. capensis*, *H. africanus*, *H. mon-*

goloideus, and *H. caucasicus*. In so doing he chooses to disregard the concept of mutual interfertility. He neglects also the earlier statement of Georges Puchet (*ca.* 1860) that "either we must admit different species in the genus *Homo*, or we must entirely revise zoological classification."

This reviewer is not so much concerned with the establishment of five human species as with the attitude, the conceptual values, behind it. The whole thing has an air of a racial (specific) hierarchy, a "superior-inferior" categorization. The sequential build-up is clear: "This eighteenth century political doctrine [that 'all men are born free and equal'] is hopelessly at variance with the facts of science. . . ." (p. 114); "there is no question of the inheritance of mental abilities and disabilities" (p. 145); " . . . the mental differences between races remain and cannot be gain-said" (p. 367). The reader is led, even though perhaps unconsciously, into a racist patterning of thought, both culturally and biologically.

The fact that this is a "bad" book is, in a sense, beside the point. What really matters is that it is *not* a "good" book. It should have been; with more care and objective thinking it could have been.

WILTON MARION KROGMAN

Graduate School of Medicine,
University of Pennsylvania

Cosmic ray physics. D. J. X. Montgomery. Princeton, N. J.: Princeton Univ. Press, 1949. Pp. viii + 370. (Illustrated.) $5.00.

A great number of physics students are nowadays turning to the subject of cosmic rays, and for some years there has been a serious need for a textbook to introduce the subject to them in their first or second year of graduate study. The need has been particularly urgent because of the lamentable state of periodical literature on cosmic rays. There is a bewildering profusion of articles on the subject—articles written in many languages, scattered throughout many journals, and full of mistakes and contradictions that a beginning student cannot be expected to sort out for himself.

Cosmic ray physics, by D. J. X. Montgomery, fills the need for such a textbook reasonably well and therefore will be heartily welcomed. It is easier to read than the recent book *Cosmic rays*, by L. Janossy (Oxford, 1948), and it is much more accurate and up-to-date than the few earlier books. Its major emphasis is on the principles underlying cosmic-ray experiments and the interpretation of experimental results. In contrast to Janossy's book, theoretical calculations are in general omitted, although the theoretical methods are broadly sketched in a qualitative fashion and some of the results of theoretical calculations are presented. The book offers little in the way of original contribution or information not published elsewhere, but is rather a survey of the cosmic-ray work up to 1948. One of its outstanding features is its exhaustive lists of references.

Montgomery's book was begun on the basis of a series of lectures on cosmic rays given by Marcel Schein at Princeton in 1946. Since then, however, the volume has been much amplified; many more recent experimental results have been incorporated, and notable contributions have been made by Niels Arley and by the late Shuichi Kusaka. Thus the author has been guided by specialists in both the experimental and theoretical branches of the subject.

There are, unfortunately, some errors in the book, and the author has occasionally taken a too credulous attitude towards an experiment or a theory. The references sometimes make no distinction between good work and bad. These, however, are not general characteristics. More commonly, Montgomery has adopted a healthy, critical view of published results, and has successfully weeded out errors. The occasional one remaining may serve as a teaching aid by stimulating students to read more carefully and critically than they would if they expected the text to be infallible.

KENNETH GREISEN

Cornell University

The pulsation theory of variable stars. Svein Rosseland. New York: Oxford Univ. Press, 1949. Pp. viii + 152. (Illustrated.) $5.00.

The wealth of unanswered questions regarding the giant stars in general and the pulsating giants in particular has attracted many astronomers in recent years to work on stellar pulsations. This work, however, has not yet given final answers to most of the essential questions. Under these circumstances the task of summarizing the present status of the pulsation theory is both extremely useful and very difficult; useful, because it may do much to stimulate the further research that is needed, and difficult, because definite facts are few to report, and many parallel investigations must be described whose relative values cannot yet be ascertained. Professor Rosseland has undertaken this task in spite of its difficulties and has completed it with singular success.

The first three chapters of the book contain the history and the basic elements of the pulsation theory. The following chapters describe the more recent developments, such as pulsational stability, the form of the pulsations in the outer parts of a star, and the effects of the nonlinearity of the basic equations. These topics are presented in a uniform and elegant mathematical form. The reading of these chapters may seem to require an appreciable effort. However, this effort should be small compared with that necessary to understand some of the original papers. The final chapter presents a comparison of the present pulsation theory with the observational data on certain critical points.

The chapter next to the last contains a discussion of shock waves. Since the book was published, the timeliness of this discussion has been amply demonstrated: new observational evidence obtained at the Mt. Wilson Observatory indicates that for some stars the pulsation in the atmosphere does indeed take the form of a shock wave.

MARTIN SCHWARZSCHILD

Princeton University Observatory

Scientific Book Register

Adams, Leverett A., and Eddy, Samuel. *Comparative anatomy.* New York: John Wiley, 1949. Pp. vii + 520. (Illustrated.) $5.00.

Alexander, A. E., and Johnson, P. *Colloid science.* (2 vols.) London: Oxford Univ. Press, 1949. Vol. 1: pp. xx + 554; vol. 2: pp. viii + 555–837. (Illustrated.)

Bailey, Virginia Long, and Bailey, Harold Edwards. *Woody plants of the Western national parks: containing keys for the identification of trees and shrubs.* (American Midland Naturalist, monograph no. 4.) Notre Dame, Ind.: Univ. Press, 1949. Pp. 274. (Illustrated.)

Barth, Lester George. *Embryology.* New York (16): Dryden Press, 1949. Pp. xii + 330. (Illustrated.) $5.00.

Bartram, Edwin B. *Mosses of Guatemala.* (Fieldiana: Botany, Vol. 25.) Chicago: Chicago Natural History Museum, 1949. Pp. v + 442. (Illustrated.) $4.00.

Blackburn, John F. (Ed.). *Components handbook.* (Vol. 17.) (Massachusetts Institute of Technology Radiation Laboratory Series.) New York: McGraw-Hill, 1949. Pp. xvii + 626. (Illustrated.) $8.00.

Bookmiller, Mae M., Bowen, George Loveridge, and Bakwin, Harry. *Textbook of obstetrics and obstetric nursing.* Philadelphia: W. B. Saunders, 1949. Pp. xvii + 737. (Illustrated.)

Chance, Britton, *et al.* *Electronic time measurements.* (Massachusetts Institute of Technology Radiation Laboratory Series.) New York-London: McGraw-Hill, 1949. Pp. xviii + 538. (Illustrated.) $7.00.

Crile, George, Jr. *Practical aspects of thyroid disease.* Philadelphia: W. B. Saunders, 1949. Pp. xviii + 355. (Illustrated.) $6.00.

Dennis, Wayne, *et al.* *Current trends in social psychology.* Pittsburgh: Univ. Pittsburgh Press, 1948. Pp. vi + 299. $4.40.

Faulkner, T. Ewan. *Projective geometry.* New York: Interscience; Edinburgh-London: Oliver and Boyd, 1949. Pp. viii + 128. (Illustrated.) $3.00.

Harnwell, Gaylord P. *Principles of electricity and electromagnetism.* (2nd ed.) New York: McGraw-Hill, 1949. Pp. xvi + 670. (Illustrated.) $6.00.

Harris, Robert S., and Thimann, Kenneth V. (Eds.) *Vitamins and hormones: advances in research and applications.* (Vol. VI.) New York: Academic Press, 1948. Pp. xi +435. $7.80.

Hepler, Opal E. *Manual of clinical laboratory methods.* (4th ed.) Springfield, Ill.: Charles C. Thomas, 1949. Pp. xv + 387. (Illustrated.) $8.50.

Hollingworth, Harry L. *Psychology and ethics: a study of the sense of obligation.* New York: Ronald Press, 1949. Pp. ix + 247. $3.50.

Hood, Samuel Stevens. (Ed.) *Archibald Henderson: the new Crichton.* New York 7: Beechhurst Press, 1949. Pp. xviii + 252. (Illustrated.) $5.00.

Inglis, David Rittenhouse. *Dynamic principles of mechanics.* Philadelphia: Blakiston, 1949. Pp. x + 174. (Illustrated.) $4.00.

Jenkins, Glenn L., DuMez, Andrew G., and Christian, George P. *Quantitative pharmaceutical chemistry.* (3rd ed.) New York-London: McGraw-Hill, 1949. Pp. xii + 531. (Illustrated.) $4.75.

Kramer, Mary Everist. (Ernest A. W. Sheppard and Louisa Wells-Kramer, eds.) *Clinical orthoptics: diagnosis and treatment.* St. Louis: C. V. Mosby, 1949. Pp. 475. (Illustrated.) $8.00.

Laton, Anita Duncan, and Powers, Samuel Ralph. *New directions in science teaching: a report of a cooperative project in seventeen secondary schools with the Bureau of Educational Research in Science, Teachers College, Columbia University.* New York-London: McGraw-Hill, 1949. Pp. xi + 164. $2.50.

Lefschetz, Solomon. *Introduction to topology.* Princeton, N. J.: Princeton Univ. Press, 1949. Pp. viii + 218. (Illustrated.) $4.00.

Lothian, G. F. *Absorption spectrophotometry.* (3rd ed. of Twyman and Allopp's *The practice of absorption spectrophotometry with Hilger instruments*). Boston (16), Mass.: Jarrell-Ash; London (N.W.1), Engl.: Hilger and Watts, 1949. Pp. 196. (Illustrated.) $7.60 postpaid.

MacLeod, Colin M. (Ed.) *Evaluation of chemotherapeutic agents: symposium held at the New York Academy of Medicine, March 25 and 26, 1948.* New York: Columbia Univ. Press, 1949. Pp. xii + 205. $4.00.

Monier-Williams, G. W. *Trace elements in food.* New York: John Wiley, 1949. Pp. viii + 511. $6.00.

Morgan, Banner Bill, and Hawkins, Philip A. *Veterinary helminthology.* Minneapolis 15, Minn.: Burgess Publ., 1949. Pp. 400. (Illustrated.) $7.00.

Pease, Katharine. *Machine computation of elementary statistics.* New York 16, N. Y.: Chartwell House, 1949. Pp. 238. (Illustrated.) $2.75.

Peters, Hans M. *Grundfragen der Tierpsychologie: Ordnungs- und Gestaltprobleme.* Stuttgart, Germany: Ferdinand Enke, 1948. Pp. viii + 117. (Illustrated.) 1 F.

Quarles, Gilford G. *Elementary photography.* (2nd ed.) New York: McGraw-Hill, 1948. Pp. xii + 345. (Illustrated.) $4.50.

von Bertalanffy, Ludwig. *Das biologische Weltbild: Die Stellung des Lebens in Nature und Wissenschaft,* (Band 1). Berne, Switzerland: A. Francke Ltd., 1949. Pp. 202. 11 fr., (Swiss); 14.50 fr., clothbound.

Yagoda, Herman. *Radioactive measurements with nuclear emulsions.* New York: John Wiley, 1949. Pp. ix + 356. (Illustrated.) $5.00.

———. *Index to the literature of experimental cancer research 1900–1935.* Philadelphia: Donner Foundation, 1948. Pp. xii + 1057. $10.00.

NEWS and Notes

G. E. Hutchinson, of Yale University, is travelling in Europe on a Guggenheim fellowship during the summer and fall. He expects to visit limnological laboratories in Great Britain, Norway, and Sweden and will spend some time at the Instituto Italiano d'idrobiologia at Pallanza.

C. P. Boner, professor of physics and director of the Defense Research Laboratory at the University of Texas, has been appointed dean of the College of Arts and Sciences, effective September 1. Dr. Boner succeeds **H. T. Parlin**, who will become dean emeritus at that time. Dr. Boner will continue his work at the Defense Research Laboratory on a part-time basis.

Ernest Sachs, professor emeritus of neurological surgery, Washington University, St. Louis, has been appointed research associate in physiology at Yale University.

John Eberhart, chief psychologist of the Training and Standards Branch of the National Institute of Mental Health, has been appointed director of research projects for the institute, effective July 1. Dr. Eberhart succeeds **Lawrence Kolb**, who has accepted a position as consultant in psychiatry at the Mayo Clinic.

Richard H. Shryock has been appointed director of the Institute of the History of Medicine and William H. Welch Professor of the History of Medicine at the Johns Hopkins University School of Medicine, effective in September. He is now professor of American history at the University of Pennsylvania.

E. C. Raney, associate professor of ichthyology at the Cornell University Department of Conservation, has been engaged by the Saltwater Sportsmen and the Massachusetts Fish and Game Association to spend the summer collecting and organizing information on the striped bass and to outline research on this species. Dr. Raney will visit research centers from Maine to North Carolina.

C. Donnell Turner, chairman of the Department of Biology, Utica College of Syracuse University, has accepted a visiting professorship in biology at the University of Rangoon. He expects to sail for Burma in July.

John E. Davis recently retired as head of the Department of Physics, William Jewell College, Liberty, Missouri. He has been a faculty member since 1907 and head of the department since 1912. He continues as professor of physics, and is succeeded by **Wallace A. Hilton** as head of the department.

Claude A. Villee, of the Department of Biological Chemistry, Harvard Medical School, who was awarded a Guggenheim Memorial Foundation fellowship for 1949–50, will study nucleoprotein metabolism at the Carlsberg Laboratory in Copenhagen with K. Linderstrom-Lang.

Visitors to U. S.

C. V. Robinow, of the Strangeways Research Laboratory, Cambridge, England, has been appointed visiting professor in the Department of Biological Sciences at Purdue University for the coming summer session. Dr. Robinow, whose field is the cytology of bacteria, particularly the nuclear structure of bacteria, will offer a course in experimental microbiology to graduate students.

Mary L. Cartwright, of the Department of Mathematics, Girton College, Cambridge, recently returned to England after an extended lecture tour in this country. At the invitation of Solomon Lefschetz, Dr. Cartwright spent three months at Princeton University as consultant on his differential equation project, which is sponsored by the Office of Naval Research.

Frederick Baltzer, professor of biology at the University of Bern, Switzerland, has been visiting the University of Colorado Medical Center at Denver, where he presented discussions of his experiments on the development of hybrid transplants in amphibians to the staff seminar on fundamental biology. Dr. Baltzer sails for Switzerland on July 7.

Leonce Bonnefil, chief of the Section of Zoology and Entomology, Department of Agriculture, Port-au-Prince, Haiti, arrived June 16 for a three-month stay. While here, he will confer with experts in the field of fish and wildlife conservation.

Recent visitors at the National Bureau of Standards were **F. W. Thomas**, head of the Technical Processing Department of the British Cotton Industry Research Association, Shirley Institute, Manchester, England; **R. C. Bevan**, principal scientific officer, Building Research Station, Department of Scientific and Industrial Research, Watford, England; **Shragga Irmay**, senior assistant and instructor at the Hydraulics Laboratory, Hebrew Institute of Technology, Haifa, Israel; **R. M. Wilcox**, Department of Physics, University of Toronto, Canada; **R. S. Airs** and **J. B. Mathews**, Shell Petroleum Company, Ltd., Thornton, England; and **L. M. Clark** and **H. E. Jones**, Imperial Chemical Industries, Ltd., Norwich, England.

Grants and Awards

The Old Dominion Foundation, established by Paul W. Mellon, has awarded $2,000,000 apiece to Yale University and Vassar College. The gift to Yale is to be used to expand its student psychiatric guidance program, which will be directed by Clements C. Fry, head of the Division of Psychiatry and Mental Hygiene of the university's Department of Health. Vassar will use the donation to establish the Mary Conover Mellon Fund for the Advancement of Education. This counseling program will be directed by Carl Binger, psychiatrist and member of the faculty of the Cornell University Medical College.

The Charles Lathrop Pack Forestry Foundation has donated $100,000 to the University of Michigan to establish a course of study leading to a master's degree in conservation. The gift will be made in grants of $10,000 a year.

The Association for the Study of Internal Secretions, at its thirty-first annual meeting in Atlantic City on June 3–4, presented the E. R. Squibb and Sons Award to Herbert M. Evans; the Ciba Award to George Sayers; the Ayerst, McKenna, and Harrison Fellowship to Ernest M. Brown, Jr.; and the Schering Fund Fellowship to D. Lawrence Wilson.

A five-year grant for research in the cause and prevention of retrolental fibroplasia has been established by the **Dunlevy Milbank Foundation Inc.,** at the Columbia-Presbyterian Medical Center, New York City. The research will be directed by John Dunnington, director of the Ophthalmological Service at the center. Algernon B. Reese, attending ophthalmologist and pathologist, will be in direct charge of the project.

Seale Harris, of Birmingham, Alabama, was awarded the **Distinguished Service Medal** by the American Medical Association at its meeting in Atlantic City. Dr. Harris is best known for his research on hyperinsulinism and its control.

The Charles A. Coffin Award—a gold medal and $1,000—was granted to the Union Electric Company of Missouri at the annual convention of the Edison Electric Institute. The award is made annually for outstanding achievement among privately owned utilities.

Fellowships

A fellowship leading to an M.S. degree in chemical engineering at the Illinois Institute of Technology will be given by the Chicago Paint and Varnish Production Club and the Chicago Paint and Lacquer Association for the academic year 1949–50. Based on competitive examination, the fellowship will grant $1,000, plus $550 tuition for two semesters to the winner. Applications should be sent to William A. Lewis, dean of the Graduate School, Illinois Institute of Technology, Chicago 16, before *July 15*.

The American Heart Association announces the availability of fellowships for research and established investigations in cardiovascular disease. Applications must be filed not later than *September 15*. Applications for a limited number of grants-in-aid for research studies in the cardiovascular field and in basic research will be accepted until *December 15*. If both fellowship and grant-in-aid are desired, the two applications should be filed together. Further information and application blanks may be obtained by writing the Medical Director, American Heart Association, 1775 Broadway, New York 19.

Colleges and Universities

The University of Toledo will offer a graduate program in glass technology beginning in 1949–50. The program will be open to students with a B.A. in chemical engineering, chemistry, or physics. Inquiries regarding the program should be directed to Walter V. Burg, Department of Chemical Engineering, University of Ohio, Toledo 6, Ohio.

A series of eight weekly lectures on the history of science will begin July 5 at the **University of Chicago.** Lecturers will include visiting professors Willy Hartner, director of the Institute of History of Science, and Karl Reinhardt, professor of classical philology, both of the University of Frankfort; and H. B. Acton, professor of philosophy, University of London. University of Chicago faculty members who will participate are John A. Wilson, professor of Egyptology and associate director of the Oriental Institute; Leo Strauss, professor of political philosophy; Earl A. Evans, Jr., professor and chairman, Department of Biochemistry; Enrico Fermi, professor of physics; and Charles C. Colby, professor and chairman, Department of Geography.

The University of Wisconsin has announced two symposia to be held during its centennial program: ''Mineral Nutrition of Plants''—September 1–3; and ''Plant Growth Substances''—September 5–7. Detailed information may be had from R. P. Lee, Division of Residence Halls, Slichter Hall, University of Wisconsin, Madison 6.

Meetings and Elections

The Second International Audiology Conference will be held in London at the Royal Society of Medicine, July 15–16. Interested professional specialists are invited to the open meeting on July 16.

The 12th International Dairy Congress will be held at Stockholm Sweden, August 15–19, for the purpose of reviewing developments and exchanging technical information in the field of dairy research. The United States, although not a member of the International Dairy Federation, has been represented at the last three congresses and this year will send a delegation of ten, headed by Ollie E. Reed, chief of the Department of Agriculture's Bureau of Dairy Industry.

The 47th meeting of the **Congress of French Psychiatrists and Neurologists** will be held at Clermont-Ferrand, September 12–18. The major topics will be the reactive psychoses; the consequences of occipital lobe surgery; and medicolegal psychiatry. The general secretary of the Congress is Dr. Paul Cossa, 29 Bd. Victor Hugo, Nice, France.

Centre National de la Recherche Scientifique announces that a colloquium on **Algebra and the Theory of Numbers** will be held in Paris, September 28–October 1. U. S. scientists invited to attend are: Oscar Zariski, Harvard University; Emile Artin, Princeton University; Garrett Birkhoff, Harvard University; and André Weill, University of Chicago.

The 31st National Metal Congress and Exposition will be held in Cleveland's Public Auditorium, October 17–21. ''Economy in Production'' will be the theme, and exhibits are planned to demonstrate what modern industrial equipment can do to effect savings in cost production.

The 1949 meeting of the **History of Science Society** will be held in conjunction with the annual meeting of the **American Historical Association** at Boston late in December. Plans are now being made for the program, and members of the society interested in submitting papers for consideration should communicate with the Chairman of the Program Committee, Professor Henry E. Guerlac, Cornell University, Ithaca, New York. No papers can be considered after *October 1.*

The Electrochemical Society elected the following officers at its recent annual meeting held in Philadelphia: Alfred L. Ferguson, professor of chemistry, University of Michigan, president; J. C. Warner, dean of Graduate Studies and head of the Chemistry Department, Carnegie Institute of Technology, vice president.

A Conference on Scintillation Counters was held in Oak Ridge on June 3 and 4. This was the second in a series of conferences sponsored by the Oak Ridge National Laboratory; the first was the low temperature symposium held last summer. The scintillation conference was attended by approximately 175 people, including 125 out-of-town visitors from universities, industries, and government agencies throughout the country.

The first day was devoted chiefly to four lectures. H. Kallmann, of the Signal Corps Laboratories, reported on the work that led to his discovery that naphthalene could be used in conjunction with a photomultiplier to count beta particles. He also described his subsequent investigations of other phosphors. F. Seitz, of Carnegie Institute of Technology, discussed the possibility of obtaining crystals that would exhibit multiplication properties similar to a Geiger counter. George Morton, of the RCA Research Laboratories, reviewed the design and characteristics of present-day photomultiplier tubes, particularly with reference to scintillation counting. P. R. Bell, physicist at the Oak Ridge National Laboratory, described his scintillation spectrometer and showed examples of its use for measuring the beta spectrum of several isotopes. This apparatus was demonstrated at the conclusion of the session.

More than a hundred members attended a dinner, after which Dr. Kallmann told about some of his work at the Kaiser Wilhelm Institute, and the tremendous difficulties he had in getting apparatus.

The second day's session was devoted to a discussion of the various aspects of scintillation counting. Several experiments in which scintillation counters were the primary tool were described. R. Hofstadter showed that gamma rays are scattered as predicted by the Klein-Nishina formula. L. F. Wouters described some of the work going on at Berkeley with fast neutrons and protons. Martin Deutsch gave an account of his work on the time of decay of the positron in various gases. Most of the day was spent in discussing photomultiplier tubes, phosphors, light collectors, and electronic circuits.

Martin Deutsch, of MIT, served as chairman of both sessions.

W. H. JORDAN

NRC News

The NRC Committee on Unesco held its semiannual meeting at Spring Mill State Park, Indiana on June 3 and 4. The whole science program of Unesco was examined and certain specific recommendations were made with regard to present and future activities.

In preparation for the current Conference on Scientific Abstracting under the sponsorship of Unesco, the committee made the specific recommendation that Unesco should subsidize two or more agencies to distribute promptly and economically reliable abstracts covering the world's literature in biology and medicine. Initial emphasis is placed on biology and medicine because Unesco has learned much in the past two years about factors that have hindered progress in this area, and further because Unesco's Committee on Biological and Medical Abstracting can readily outline a detailed program for immediate action. A concerted attack upon the problem for a limited area is favored over an attempt to establish in the near future an over-all coordinating office for scientific abstracting.

The committee endorses the existing Unesco program of grants-in-aid to the international scientific unions, and urges its continuation. It urges in addition that the United States Government make available adequate funds for travel expenses of its representatives to international meetings so that they will be chosen because of their scientific standing and the contribution that they can make to a professional meeting, rather than because they individually are able to finance their travels. It is suggested that a minimum of 25 percent of the funds provided for United States representation be used to finance the attendance of scientists under thirty-five years of age.

The committee formally accepted a report submitted to the Department of State recommending that a limited number of United Nations research laboratories be established in the near future. The committee recommends immediate favorable consideratoin of three projects: an international computational center or a mathematical and statistical consulting center, to be established somewhere in Central Europe; an institute for individual and social psychology, working directly with the United Nations; and an institute of geomedicine, the latter possibly as a joint project for Unesco and the World Health Organization.

The committee learned with regret that certain difficulties have arisen with regard to the formal ratification of the agreement for the establishment of the International Institute of the Hylean Amazon. The Committee urges the U. S. National Commission for Unesco to use its good offices in investigating the reasons for the delay and in promoting healthy conditions for the growth and development of this institute, which should be a model of Unesco's work.

The committee expressed a deep interest in the new Technical Assistance Program of the Economic and Social Council of the United Nations and approved the way in which Unesco is collaborating in this important activity. The committee urged that the local population should be given important responsibilities in the execution of the program and that careful attention be paid to the effect of the assistance upon the cultural, political and social conditions of the population. It urged further that in the agricultural and industrial training program, full advantage be taken of experience gained through existing projects, and that in technical training programs emphasis be put on the development of small rural industries and on teaching by the apprentice method. Attention was drawn to the importance for wide areas of the world of improving fishing methods and handling of the catch. The committee recommended that, to supplement the local technical training programs, opportunities for further training at home and abroad should be provided for technicians who show marked ability. It is hoped that Unesco will emphasize those phases of the program which involve participation or cooperation of several countries and that colonial and minority people may have a voice in the program through the Trusteeship Council of the United Nations.

In a letter addressed by the committee to the chairman of the National Research Council, the suggestion was made that the present inadequate representation of science in the Department of State can be remedied by the establishment of the Office of the Special Advisor in Science to the Secretary of State. The special advisor should be on a full-time basis and be available for consultation not only to the Secretary of State, but also to the Assistant Secretaries for the United Nations, for Economic Affairs, and for Public Affairs. To discharge his duties properly, the Special Advisor in Science should be provided with an adequate professional staff in Washington. In addition the committee attaches great importance to the assignment to embassies abroad of foreign service officers, or special scientific attachés with specific training in a branch of science but broad general scientific interests.

The committee expressed great interest in a suggestion made by Consumers Union of the United States, proposing a project to promote wider international exchange of information on techniques of consumer testing and a parallel program of consumer education. The committee voted to make a further study of these projects before submitting a definite proposal to the U. S. National Commission for Unesco.

Copies of the full texts of the various resolutions may be obtained from the chairman of the NRC Committee on Unesco, Bart J. Bok, Harvard Observatory, Cambridge 38, Massachusetts.

Deaths

William D. Webster, 65, instructor in zoology, University of Nebraska, died May 13 of a heart attack at Lincoln, Nebraska.

Arthur W. French, 80, professor emeritus of civil engineering at Worcester Polytechnic Institute, died at his home on May 27. Dr. French was a pioneer in the use of reinforced concrete.

Walter Elmer Ekblaw, 67, professor of geography at Clark University, died on June 5 at his home in North Grafton, Massachusetts. Dr. Ekblaw was associated from 1913 to 1917 with Donald MacMillan on the Crocker Land Expedition to the Arctic, and was a charter member of both the Explorers Club in New York and the Cosmos Club in Washington.

George Brewer, 46, physiologist, died June 12 at Doctors' Hospital, Washington, D. C. Dr. Brewer was a former professor of physiology at the medical schools of both Georgetown and George Washington Universities.

James Purves-Stewart, 79, neurologist, died in London on June 14. Sir James, who received his knighthood in 1918, is the author of *Diagnosis of nervous diseases.*

The Veterans Administration Hospital, Hines, Illinois, is looking for a biophysicist to take charge of a newly established neuropsychiatric laboratory in the research service. Applicants should have either a Ph.D. in biophysics or a Ph.D. in biochemistry with a minor in biophysics, and should be experienced in medical research. The beginning salary for the position is \$6,235 a year, with periodic increases up to a maximum of \$7,192.

Headquarters for the newly created **Uruguayan Association for the Advancement of Science** (Asociación Uruguaya para el Progreso de las Ciencias) have been established in Montevideo. The aims of the association include the development of all branches of science and the initiation of new, specialized subjects; the creation of scholarships for scientific research; a program of collaboration with the University of Montevideo to achieve the maximum development of its scientific research; liaison among scientific investigators working in the same or different fields; the securing of scientific investigators from other countries to work in Uruguay; and the maintenance of a clearing house for exchange of information with foreign institutions, particularly on scientific activities and publications.

Correspondence may be addressed to the president, Professor Clemente Estable, Instituto de Investigationes en Ciencias Biológicas, Millán 4096, or to the secretary, Professor O. J. Maggiolo, Instituto de Máguinas, Facultad de Ingeniería, Cerrito 73, Montevideo, Uruguay.

Recently Received—

Chemical Production of Lactic Acid from Sugars by Rex Montgomery. Scientific Report Series No. 11. Copies available without charge from Sugar Research Foundation, Inc., 52 Wall Street, New York 5, N. Y.

Non-Linear Vibrations by Mary L. Cartwright. Reprinted from *The Advancement of Science,* April 1949. Available from the British Association for the Advancement of Science, Burlington House, London, W.1., England at 1/1d.

Prospecting for Uranium. Published by the Atomic Energy Commission and the U. S. Geological Survey. Available from the Supt. of Documents, U. S. Govt. Prntng. Office, Washington 25, D. C. at 30¢.

Notation on a Color System by Louis Cheskin. Available from Color Research Institute, Chicago 3, Illinois at 50¢.

An Institute of Microbiology—Its Aims and Purposes

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MICROBIOLOGY comprises the field of knowledge of various microscopic forms of life including the bacteria, fungi, yeasts, actinomycetes, protozoa, and algae. This science embraces a study of the occurrence of microorganisms in nature, their nutrition, their structure and life cycle, their role in numerous natural processes, and their relation to man, to domesticated and wild animals and plants, and to one another.

Although various microbes have been utilized by man since time immemorial and although some of the diseases caused by microbes have been combated since prehistoric man, the science of microbiology is of very recent origin. One of the youngest of sciences, it was hardly recognized as such a hundred years ago. Particularly striking progress has been made in late years, however, in our knowledge of the fundamental aspects of the physiology and nutrition of microorganisms and in the practical applications of this knowledge. In a relatively brief time, an important field of science has come into being—a science with applications in virtually every field of human endeavor. Microorganisms are recognized now as playing very important roles in natural processes; they are the most important causative agents of human, animal, and plant disease; they are the cause of fermentation and therefore play an important part in certain industrial processes and in the preparation of many foodstuffs and beverages; they are largely responsible for food spoilage, deterioration, and destruction of all types of materials, ranging from textiles to steel pipes; and finally they are recognized as the all-important agents in a great number of soil processes. More recently, with the development of our knowledge of the production of antibiotics and their use for combating a wide variety of diseases, microorganisms have come to occupy another highly important role in human economy.

Unfortunately, microbiology was heretofore treated as an inferior among the older sciences. It was usually considered a handmaiden of various applied sciences and, as such, was accorded a second place. It was always subservient to such fields as medicine, where it was closely tied up with pathology; public health, where it was associated with sewage disposal and sanitary conditions in general; and agriculture, where it was concerned largely with soil processes, composts, and the preparation of silage and foodstuffs.

Microbiology, it may be said, has not yet come into its own. This may be due partly to the fact that the two greatest early bacteriologists were interested not in microbiology as a fundamental science, but rather in its applications. Louis Pasteur was a chemist and Robert Koch was a clinician. They were more concerned with brewery and fermentation problems on the one hand, and with infectious diseases on the other, than with the organisms causing these. It is true that Ferdinand Cohn, a botanist, fully appreciated the significance of bacteria as biological systems, but neither he nor the botanists following him recognized the great importance of this observation; they allowed the medical people and the fermentation industries to take over microbiology and, primarily, its application. Microbes were thus considered as agents responsible for certain diseases or for certain important natural processes; they were to be either discouraged or encouraged, whichever the case might be, but they were to receive only scant recognition as independent biological systems.

It is further important to note that the general tendency has been, until recently, to limit the subject of microbiology largely to the study and utilization of bacteria. It was, for example, only four or five years ago that a group of botanists came to the conclusion that microbiology is a field of knowledge in itself. They then proceeded to recognize it by organizing a new society of microbiology—apparently in order to correct the blunder made by the botanical world some seventy-five years ago, in failing to recognize the great potential importance of the bacteria and other microscopic forms of life studied by Ferdinand Cohn.

On the other hand, many bacteriologists have also erred in this direction, some going so far as to consider the disease-producing bacteria as the only microscopic forms of life worth studying. The very large number of saprophytic microorganisms which comprise bacteria, fungi, and actinomycetes, were usually either dismissed from consideration entirely or referred to casually as organisms that belong to the domain of soil bacteriology, and have, therefore, limited importance. One illustration will suffice. William Bullock, an outstanding British bacteriologist, who has contributed to the science of microbiology one of the most comprehensive histories of the subject, not only omitted consideration of the fungi and the actinomycetes, but even among the bacteria he gave little or no attention to the autotrophic and to the nitrogen-fixing organisms—two groups of bacteria that occupy a unique place in microbiology because of their specific physiological properties, their significance in bacterial taxonomy, and their great economic importance.

Because of such neglect, even on the part of experts in the field, many microbiologists felt rather skeptical about proper recognition of their branch of science. In addressing the Third International Congress of Microbiology on the eve of World War II, Prof. Kluyver, one of the leading microbiologists in the world today, spoke bitterly of the lack of recognition of microbiology as a field of science. He even anticipated attacks upon his lecture, and said that some critic might write: "The lecture gave additional evidence of the correctness of my earlier statement that it is questionable whether bacteriology is entitled to the rank of science. And if some benevolent judge might be willing to answer this question in the affirmative sense, then it should be remarked that the lecture showed once more that bacteriology is a science which has no laws and almost no bacteriologists."

Kluyver was not the only microbiologist who voiced bitter disappointment in the prevailing attitude toward this science. By way of another illustration, I cite a statement made privately to me by another prominent microbiologist, Charles Thom, formerly of the United States Department of Agriculture, to the effect that a colleague of his once remarked that soil microbiology had been *the most futile field of labor*—judged by what it produced—that he had any knowledge about.

It is not my purpose either to defend the science of microbiology or to magnify its great theoretical and practical importance. I only emphasize the fact that during the last few years microbiology has had focused upon it the attention of both the scientist and the practical man. I should like to give consideration here to the importance of only two groups of microorganisms—namely, the fungi and the actinomycetes, both of which previously were largely neglected, except in certain limited fields of application.

At no time in past history have these two groups of microorganisms played so great a part in the affairs of man as during World War II. Few laymen, even among those who participated in the war, appreciated the great importance of the fungi—as agents of destruction of essential materials, as causative agents of human diseases, and as producers of drugs, such as penicillin, that could be utilized successfully for combating many of the diseases caused by bacteria. Because of these important activities, the fungi tended to overshadow even the bacteria and other microbes, notably the protozoa and the viruses, in spite of the fact that these continued their important role in human economy, especially in the causation of disease and epidemics.

It is true that fungi have long been recognized as having great potentialities for destroying a great variety of materials. This was appreciated particularly by the plant pathologist, who was continuously faced with the fact that fungi are more concerned in the diseases of cultivated and wild plants and cause greater damage than all other organisms combined, with the possible exception of insects. The soil microbiologist, too has long known that fungi are responsible for the major destruction of the plant and animal residues in composts and in soil, and thus not only contribute to the removal of wastes, but also lead to the liberation in available form of the chemical elements essential for plant growth. And fungi are no strangers to the housewife, who in her attempt to preserve jams, jellies, bread, and other foodstuffs, is continuously faced with the problem of combating spoilage by a great variety of molds. The lover of mushrooms also appreciates the fungi, but as a friend rather than as an enemy. The great potentialities of fungi have also been recognized in certain other fields of human endeavor. It is sufficient to mention the manufacturer of foods, such as cheeses; of beverages, such as beer and distilled liquors; and of industrial products, such as citric acid, gluconic acid, fumaric acid, ethyl alcohol, and glycerol.

As already mentioned, it was only during the last war that full recognition was given to the great importance of fungi. With the concentration of large quantities of service materials in tropical and subtropical areas under the prevailing conditions of high humidity and high temperature, the damage potential of the fungi became apparent. Fungi attacked optical and electrical equipment, clothing, tents, and other materials used by service personnel, and even infected the human body. Although the physiology of the fungi and methods of their control had received much consideration, especially by plant pathologists and soil microbiologists, discoveries in these fields did not lend themselves readily for application to the problem at hand. Thus a rapid survey had to be made of the nature of the fungi causing the damage, the added role of bacteria, insects, mites, and other lower forms of life, the nature of the damage brought about, the nature of the fungistatic and fungicidal agents required to protect different kinds of service materials, the methods for measuring the protection thus rendered, and a host of other problems. It was only natural that all these problems, dealt with under pressure of wartime conditions, were studied largely from the point of view of immediate necessity and not from that of a fundamental science. Here was a biological problem that should have been investigated in great detail, so that information would have been ready for immediate use. It required the coordinated efforts of many investigators, and resulted in great accomplishments, none greater than the emphasis laid upon the importance of fungi in natural processes.

Antibiotics were another wartime development. Just on the eve of World War II, I said in a public address: "We are finally approaching a new field of domestication of microorganisms for combating the microbial enemies of man and of his domesticated plants and animals. Surely microbiology is entering a new phase of development. This new phase has now been called the subject of antibiotics."

Just what are antibiotics? This question was placed before me less than eight years ago, in 1941. The following definition is based upon my earlier designation of the term: "An antibiotic or an antibiotic substance is a substance produced by microorganisms, which has the capacity of inhibiting the growth and even of destroying other microorganisms." The action of an antibiotic against bacteria and other microorganisms, as distinct from common antiseptics and disinfectants, is selective in nature, since only some bacteria are affected by a given agent, and others not at all, or only to a limited extent. Antibiotics vary greatly in their toxicity to animals and in their activity *in vivo*. Because of these characteristics, only a very few of the antibiotics so far isolated have received recognition as chemotherapeutic agents.

I need hardly dwell upon the great progress made in the field of antibiotics during the last seven or eight years. Although the chemist feels somewhat slighted because the clinician is claiming most of the credit for developing this field, and although the pharmacologist and physiologist have made their important contributions, you will agree with me that it is the microbiologist who is entitled to the credit for having opened up this field of science and for continuing to make substantial contributions to its development.

What has been said of the importance of fungi applies to a greater extent, though in a somewhat different way, to the actinomycetes. Here is a large and heterogeneous group of microorganisms which had aroused little interest on the part of the microbiologists or any other group of investigators. An important plant disease or two, a rare and peculiar human or animal infection encountered at very infrequent intervals, abundant occurrence in the soil—this much was known about the actinomycetes—but nobody cared to waste much time in determining what these delicate, mycelium-producing, odoriferous, microscopic forms of life do either in the soil or in a manure pile. It is the field of antibiotics that has focused attention upon the possibility of utilizing certain hidden physiological properties of these organisms. When one realizes that twenty percent or more of all actinomycetes that are freshly isolated from natural substrates have been found capable of inhibiting the growth of bacteria or other microorganisms, one comes to appreciate their great potentialities in this respect.

Thus our recently developed knowledge of vitamins and their role in human nutrition, of the utilization of penicillin, streptomycin, aureomycin, chloromycetin, and other antibiotics in the control of disease, of the potential part that bacteria may play as agents of biological warfare, of the destruction of service materials under tropical conditions, of industrial fermentations, and of many other microbiological processes has focused renewed attention upon the vast number of applications of microorganisms and their great importance to our economy, public health, and medicine. It is, therefore, essential to recognize these developments and to plan a comprehensive study of the fundamental aspects of the nature and activities of various groups of microorganisms, their role in natural processes, and their use in agriculture, industry, public health, and other aspects of human economy.

With this in view, an Institute of Microbiology is being established by Rutgers University. In this institute particular attention will be devoted to the fundamental aspects of the study of microorganisms, their physiology, their biochemical activities, and their relations to higher forms of life, notably to man and to his domesticated animals and plants. In other words, microbiology will be treated as a fundamental science. Certain of the practical or applied phases resulting from these studies will be carefully examined by other divisions of the institute.

In planning the program of the Microbiological Institute, the broad field of microbiology is conceived as covering six of the major groups of microorganisms, namely bacteria, actinomycetes, filamentous fungi or molds, yeasts, protozoa, and viruses. Minor consideration may also be given to other groups, such as the higher or mushroom fungi, the algae, certain worms, and other microscopic forms of life.

The functions of the institute will comprise both research and teaching, largely on graduate student and postdoctorate levels. The staff of the institute will offer courses in the various fields of microbiology to graduate students at Rutgers University and will conduct seminars for graduate and postdoctorate students. These courses will also include supervision of various research problems, in both the fundamental and the applied phases of the subject. The institute will serve as a gathering place for seminars and conferences on microbiological subjects. It will also serve as a depository of cultures of microorganisms of theoretical or practical importance.

Although it is not intended to overorganize or departmentalize the Institute of Microbiology, it is tentatively proposed that it should include six major divisions or fields of research:

I. *General Microbiology.* This division will be concerned with the study of the structure and functions of microorganisms. Particular attention will be paid to morphology, cytology, genetic characteristics, taxonomic relationships, and ecology.

II. *Microbial Physiology.* This division will be concerned with the study of the physiology of different groups of microorganisms, their nutrition, intermediary metabolism, and other biochemical properties. Its program will include studies of the physiology of certain representative types of organisms found among the pathogenic and saprophytic bacteria, fungi, actinomycetes, viruses, and others.

III. *Antibiotics of Microorganisms.* This division will be concerned with the study of the formation of antibiotics by microorganisms, their isolation and purification, their chemical composition, their mode of action upon bacteria and other microorganisms, and their utilization for disease control. Particular attention will be paid to the isolation of antibiotics active against *Mycobacterium tuberculosis,* against viruses, and possibly against tumor cells also.

IV. *Vitamins and Enzymes.* This division will be concerned primarily with the study of the role of vitamins and enzymes in the nutrition of microorganisms, their production under different conditions of growth, and their utilization.

V. *Ecology of Microorganisms.* This division will be concerned with the occurrence, activities, importance, and control of microorganisms in soils, composts and water basins, in various agricultural products, and in foodstuffs.

VI. *Applied Microbiology.* This division will deal primarily with the application of microorganisms. Problems given consideration here will be largely of a practical nature. It is sufficient to mention such fields as the microbiology of foodstuffs, microbiology of soils and manures, microbial fermentations, causation of spoilage and methods of control, antiseptics and disinfectants, and finally—and not least important—the relations and interrelations of microorganisms in human, animal, and plant diseases.

Although the highly important fields of medicine, veterinary science, and various concomitant branches, such as immunology and disease control, will be avoided in principle, certain aspects will be considered in connection with some of the work proposed for the institute whenever the problems under consideration necessitate the study of disease-producing organisms, their physiology, and methods of control. This may involve collaboration with pharmacologists and medical investigators in industrial laboratories and in medical institutes.

Surely microbiology may be said to have come of age. Surely the establishment of an institute which is to be devoted to the task of training advanced students in the field of microbiology and to planning a program of research in the fundamentals of microbiology needs no apology. It is a great field, rich in scientific potential and in practical applications. The future for this field is bright indeed.

Based on an address delivered May 3, before representatives of the press and radio, on the organization of the Institute of Microbiology at Rutgers University, the State University of New Jersey.

On the Interpretation of the Absorption of Ultraviolet Light by Cellular Nucleic Acids

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EFFORTS TO EXTEND the field of quantitative biochemistry to the level of the single cell have been based largely on absorption spectrophotometry. This method has suggested a means of determining intracellular concentrations of specific substances by virtue of the proportional relationship between the number of molecules in the light path and the extinction at the wavelength characteristically absorbed by the compound in question. ($E = \log I_0/I = \varepsilon cd$).[1] This relationship, the Beer-Lambert law, usually holds for the absorption of light by gases and solutions, and—for the purpose of determining intracellular concentrations—is *assumed* to be true for the physical states encountered in living and dead cells (*8, 17, 18, 32, 33*). Conclusions based on this assumption have led to the development of a number of theories concerning the biochemistry of the nucleus, nucleic acid metabolism, protein synthesis, and metabolism of tumor cells (*8*).

However, it has been recently suggested (*12*) that the amount of light specifically absorbed by the substance under study may vary considerably with the degree of orientation imposed on the material. It was shown that when the following two conditions exist together, materials will fail to absorb more than one-half the incident light and thereby depart widely from the Beer-Lambert law: (a) the molecules absorb light by virtue of a distinctive electronic axis (i.e., one occupying a unique position in the structure of the molecule) and (b) the molecules exist in an oriented aggregate.

Most intracellular extinction measurements have been intended as determinations of intracellular nucleic acid content, and these data have figured largely in the development of the theories cited above. It would seem important, therefore, to determine to what degree the two conditions required for anomalous absorption apply to the nucleic acids occurring in cellular structures. As will be shown below, such an analysis suggests that the extinctions of intracellular objects at 260 mμ do not necessarily reflect their actual nucleic acid content, and that considerable caution must be used in interpreting such data.

Optical properties of nucleic acids.

The characteristic ultraviolet absorption of the nucleic acids is a property of their constituent purine and pyrimidine bases. According to the theory of color developed by Lewis and Calvin (*21*), the absorption of light is due to specific electronic oscillations within the structure of a molecule. Hence, for planar molecules such as the purines and pyrimidines, these oscillations can be resolved into lines in this plane.[2] As shown by Lewis and Calvin and by Ferguson (*13*), molecules which are nonsymmetrical with respect to the position of the groups responsible for their color have two fundamental electronic axes, both lying in the plane of the molecule. These axes are characterized by different wavelengths, the oscillation of lower energy representing the absorption maximum at the longer wavelength.

In some cases Lewis and his collaborators (see reference *12* for references) have localized these axes with respect to the dimensions of the molecule by determining the effect of the plane of polarization of the incident light on the extinctions yielded by molecules in rigid media. They have shown for such cases that the extinctions at the two characteristic wavelengths reach maxima at planes of polarization which are at 90 degrees to each other.

Unfortunately, comparable data for the nitrogen bases are lacking, and in discussing them one is forced to deal with assumptions based on analogy with the molecules studied by Lewis *et al.* The lack of symmetry of the nitrogen bases suggests that they possess two distinctive absorption axes lying in the plane of the molecule. Except for guanine, these substances yield a single maximum in the ultraviolet (see Hotchkiss, *16*) at 260–265 mμ in neutral solution. This maximum must represent either (a) the absorption due to one of the two distinctive axes; or (b) absorption due to both axes.

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[1] E = extinction, I_0 = intensity of incident light beam, I = intensity of transmitted beam, c = concentration of absorbing material in moles/liter, d = thickness of the sample in cm, and ε = molar extinction coefficient.

[2] Such molecules may have a third axis representing electronic oscillations perpendicular to the plane of the molecule. The energy level of such oscillations is so high that this axis is characterised by light absorption at wavelengths too short to fall within the range involved in ordinary spectrophotometry of solutions. This type of absorption will therefore not be considered.

If the first assumption is the correct one, the maximum at 260–265 mμ must represent one of the axes, and the second axis must account for an absorption maximum at a significantly shorter wavelength. The second maximum would probably lie in the range below 220 mμ and therefore be undetectable by spectrophotometry of solutions. If alternative (b) is the correct one, the axes must be characterized by nearly identical wavelengths. In the absence of critical data, it is of course impossible to choose between these alternatives, but on the basis of what is known about the optical properties of nonsymmetrical molecules, the second alternative seems the less likely one. Hence for the purposes of this discussion we shall assume that the absorption of the nitrogen bases (other than guanine) at 260–265 mμ is due to a distinctive electronic axis which lies in a unique position with respect to the dimensions of the molecule. If this assumption is incorrect, the analysis which follows is altered in certain details, which will be noted below.

The structure of nucleic acids has been discussed by Astbury (*1*) who concludes that the constituent nucleosides are arranged in a parallel stack, so that the entire molecule has the configuration of a roll of coins (where each coin is a nucleoside). He also suggests that each nucleoside is probably oriented in the same way with respect to the long axis of the molecule, thereby placing the rings of the nitrogen bases in complete alignment along the length of the molecule.

It follows, therefore, that the absorption axes of the nitrogen bases which account for the extinction of nucleic acids at 260 mμ must be rigidly oriented throughout the entire polynucleotide. Although the available data are insufficient to describe completely their position with respect to the dimensions of the nucleic acid molecule, these axes must lie in planes perpendicular to the long axis of the molecule. This is in accord with Schmidt's observation (*27*) that the birefringence of thymonucleate fibers is negative with respect to the long axis of the fiber, and the finding of Signer, Caspersson, and Hammersten (*30*) that flow birefringence is negative to the direction of flow. It also agrees with Caspersson's observation (*7*) that for maximum absorption at 257 mμ by partially oriented films of thymonucleic acid, light must be polarized in a plane perpendicular to the long molecular axis.

Similar results have been obtained by Butenandt *et al.* (*3*), who studied the absorption spectrum of flowing solutions of tobacco mosaic virus with plane polarized light. They found that the extinction at 260 mμ was at a maximum when the light was polarized in a plane perpendicular to the direction of flow (and therefore also perpendicular to the long dimension of the molecules oriented by flow), and concluded that the absorbing groups must occupy planes perpendicular to the long axis of the virus nucleic acid (which parallels the long axis of the virus particle itself).

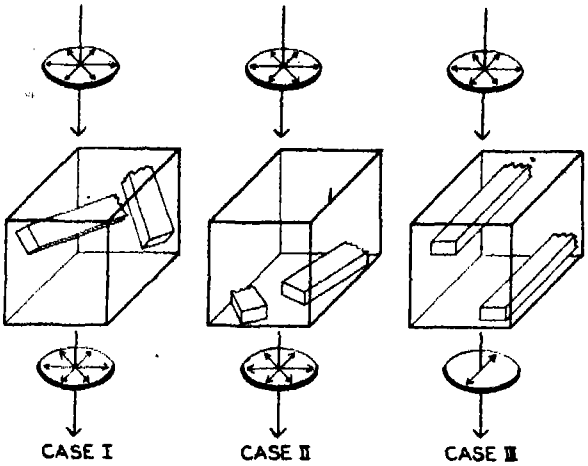

FIG. 1A. The effect of orientation of nucleic acid on the absorption of unpolarized light. The nucleic acid molecule is represented as an elongated oblong prism (only part is shown) whose smallest face is parallel to the planes occupied by the nitrogen bases. In Cases I and II light of all electric vectors is equally transmitted; in Case III only light with a vector perpendicular to the long axis of the molecule is transmitted. Since this represents 50% of the incident light, Case III gives a maximum extinction of 0.3. The dimensions of the molecule are arbitrary.

This visualization of the optical structure of nucleic acid molecules makes possible consideration of the effect of molecular orientation on the extinctions yielded at 260 mμ. Since the preponderance of the constituent nitrogen bases (i.e., except guanine) probably contribute to the absorption by virtue of a distinctive electronic axis, and appear to be rigidly ordered along the length of the polynucleotide, the orientation of these axes is determined by the position of the molecule itself.

Hence we may consider the three cases of orientation of optical axes discussed in reference (*12*) in terms of the possible types of orientation of the nucleic acid molecule proper. These are diagramed in Fig. 1A. In Case I, the molecules, and the axes responsible for the absorption at 260 mμ, are randomly distributed in space. The relation between the number of molecules scanned (*N*) and the extinction (*E*) at 260 mμ is therefore a straight line, and the Beer-Lambert law is obeyed. In Case II the orientation is at random within a series of parallel planes. The relation between E and N is again linear, but not identical with that of Case I. In Case III the molecules, and therefore the absorption axes, are completely oriented in three dimensions. Consequently, the relation of E to N is nonlinear above very low E values, and the system departs radically from the Beer-Lambert law. In this type of orientation, the fraction of incident light absorbed cannot rise above 1/2 and E cannot exceed 0.3. As a result, E becomes independent of the number of molecules scanned as N increases.

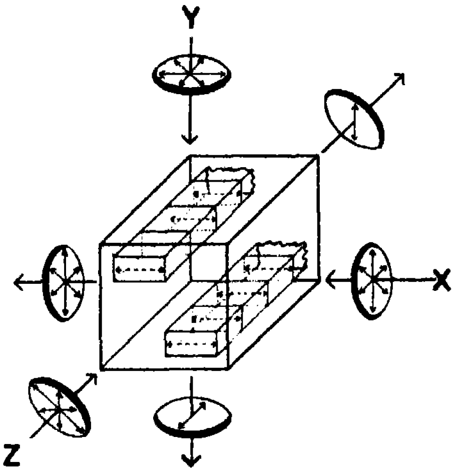

FIG. 1B. The absorption of unpolarized light impinging on an oriented aggregate of nucleic acid molecules from various directions. The nitrogen bases are represented as planes parallel to the front (smallest) face of the molecule; the dotted arrows in these planes represent the position of the distinctive electronic axis responsible for the absorption at 260 mμ. The dimensions of the molecule are arbitrary.

This description pertains to the situation in which the nucleic acid molecules are oriented with their long dimension perpendicular to the direction of the incident light beam. Since this relationship may not always be true of cytological preparations, the properties of oriented aggregates viewed from all possible directions need to be considered.

Fig. 1B describes the optical properties of a fully oriented nucleic acid aggregate when the incident light beam impinges on it from various directions. As shown in Fig. 1A, when the incident beam is perpendicular to the long dimension of the molecule and also to the distinctive absorption axes of the nitrogen bases (i.e., the beam parallels the Y axis), only light with an electric vector parallel to the planes of the nitrogen bases can be absorbed. Thus, the emergent beam is plane polarized and necessarily represents a minimum of 1/2 the energy of the incident beam. The limit of E is therefore 0.3, regardless of the number of molecules in the path of the beam.

The same effect occurs when the incident beam is propagated along the Z axis (parallel to the long dimension of the molecule), for here, too, the beam is perpendicular to the absorption axes. Thus, if the aggregate is examined from the direction of the Y axis, or the Z axis, or from any intermediate direction, the absorption effects typical of Case III occur.

When the incident beam is parallel to the X axis, and is therefore also parallel to the absorption axes of the nitrogen bases, the probability that any photon will be absorbed is zero, and the molecule is transparent (at 260 mμ) from this direction. Consequently E is zero for all N values. For beams impinging from directions between the X and Y axes, and between the X and Z axes, the relation between E and the number of molecules will be as follows: E cannot rise above 0.3, but (with increasing values of N) will approach this limit more slowly that it does when the beam is on the Y or Z axis.

Thus, if (as assumed) the absorption at 260 mμ by an oriented nucleic acid aggregate is determined by a distinctive absorption axis, extinctions greater than 0.3 cannot occur, regardless of the direction from which the aggregate is examined. Differences in the direction of the impinging beam only affect the rate at which this limit is approached with an increase in the number of molecules in the beam's path. This suggests that cytological preparations which contain oriented aggregates of nucleic acid may yield extinction values which do not follow the Beer-Lambert law and therefore are not necessarily proportional to the number of molecules scanned.[3]

The orientation of nucleic acids in cell structures.

While there is considerable information on the orientation of molecular aggregates in cellular structures, decisive data on the orientation of nucleic acids proper are rather sparse and contradictory. Most of the evidence is summarized in the exhaustive reviews of Schmidt (*27*), Frey-Wyssling (*14*), Schmitt (*28*), and Monné (*22*), and unless otherwise indicated, references relative to the discussion which follows may be found in these sources.

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[3] If the nucleic acid absorption at 260 mμ is *not* due to a distinctive electronic axis, these relationships are altered as follows: (1) Case I and Case II yield identical straight lines. (2) In Case III, the limit of E is 0.3 when the incident beam parallels the Y axis or the X axis or any direction between these two. When the beam impinges along the Z axis, the relation of E to N is linear and the Beer-Lambert law is obeyed. For positions between the X and Z axes, and the Y and Z axes, the relation of E to N is not linear, but approaches the extreme (in which the limit of E is 0.3) as the X and Y axes are approached. Thus, even if it is not assumed that the nucleic acids are characterized by a distinctive absorption axis at 200 mμ, oriented aggregates will not follow the Beer-Lambert law except in the rare case when the molecules are examined from a direction exactly parallel to their long dimension.

That preparations of extracted nucleic acids may form fully oriented aggregates is evident from Caspersson's observations (*7*) of dichroism in thymonucleate gels. Such aggregates are also birefringent, the sign of this effect being negative with respect to the long axis of the aggregated molecules. This provides a method of distinguishing birefringence due to nucleic acids from that due to aggregates of parallel protein chains, for the sign of the latter is positive with respect to the long axis.

Practically all cytological structures may be birefringent under the proper conditions. The effect is frequently due to parallel orientation of protein fibers with their long axes perpendicular to the light beam. This orientation appears to persist in structures such as muscle fibers, chromosomes (in condensed stages), myofibrils, and cilia. In undifferentiated living cytoplasm birefringence is common but highly variable in degree, and may be elicited by dehydration, mechanical stress, and chemical treatment. Here, too, protein fibers seem to be frequently responsible for the optical property.

On purely theoretical grounds, these results suggest that the nucleic acids in cell structures may exist as aggregates so oriented as to elicit the absorption anomalies. Astbury and Bell (*2*) have shown that the internucleotide spacing of the nucleic acid molecule is practically identical with the spacing of side-chains along the protein polypeptide skeleton. This suggests that the nucleoprotein complex probably involves a side-by-side binding of the thread-like protein molecules with the equally elongated nucleic acids. This would mean that in any structure containing nucleic acids these would be oriented in the same way and to the same degree as the proteins with which they are combined. This occurs in tobacco mosaic virus (*3*).

Direct evidence on this possibility is difficult to obtain from measurements of birefringence. In a few cases, such as sperm heads, the nucleic acid content is sufficiently great to give the entire structure negative birefringence, indicating that the nucleic acid is in an oriented state. In most structures, however, the nucleic acids are present in small concentrations in comparison with protein. The negative birefringence caused by the nucleic acids thus cannot counteract the large opposite effect due to the protein present. As Caspersson (*7*) has pointed out, the birefringence expected from the usual concentrations of nucleic acid lies close to the limits of the method. Hence, the failure to detect negative birefringence, where the proteins are themselves oriented, cannot be taken as evidence that the nucleic acids are not oriented.

It is not surprising, then, that the only unequivocal evidence for orientation of nucleic acids comes from studies of sperm heads. Schmidt (*27*) detected a strong negative birefringence in this case, and concluded that the nucleic acid molecules were oriented in lines parallel to the long axes of the protein fibers. This was confirmed by Caspersson's observation of dichroism at 257 mμ in the sperm bundles of a locust (*7*).

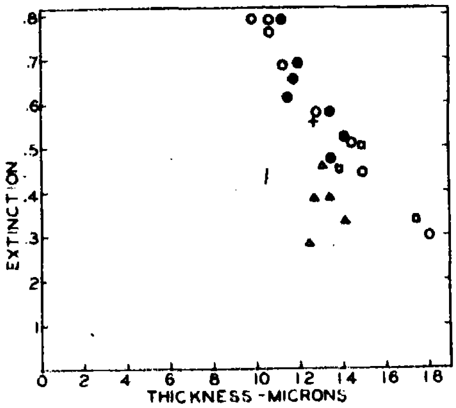

FIG. 2. The relation between extinction at 257 mμ and the thickness of nuclei of spermatocytes of *Gomphocerus*. Data taken from Table 1 of reference 5. Triangles represent nuclei in early leptotene; open circles—late leptotene; plus sign—synizesis; closed circles—pachytene; squares—diplotene.

The evidence for the orientation of nucleic acid in chromosomes is contradictory. Schmidt (*27*) found that the chromomere discs of salivary gland chromosomes have a weak negative birefringence, and concluded that the nucleic acid was oriented as in sperm heads. However, Frey-Wyssling (*14*) concludes from quantitative determinations of the optical properties of the chromomeres that only a small percent of the nucleic acid molecules are oriented. Furthermore, Caspersson (*7*) failed to find the dichroism at 257 mμ expected from Schmidt's conclusions. Caspersson suggests that the insect salivary gland chromosome is not of typical composition, and he does not consider these data sufficient to rule out the probability that nucleic acids are oriented in most chromosomes. Negative birefringence has been demonstrated in chromosomes of a number of animal and plant cells, as well as in "resting" nuclei. This property is variable in degree, and marked changes (including changes in sign) may result from environmental effects and fixation procedures.

Extinctions yielded by cellular nucleic acids.

Since both conditions required for the appearance of nonlinear relations between E and N (i.e., absorption due to a distinctive axis, and orientation) may apply to the intracellular nucleic acids, it is of interest to examine the data obtained from such objects for evidence of this anomaly.

Demonstrations that intracellular extinctions at 257–260 mμ do indeed follow the Beer-Lambert law would dismiss the possibility that the orientation effect is of any consequence. As far as the writer is aware, there are only two published descriptions of a direct test of this relationship in cells, and neither involves naturally-occurring solid structures. Pollister and Ris (*25*) have shown that the extinction yielded by the colored substance produced in the Millon test for proteins is directly proportional to the thickness of the test section. Since the structure of the compound is unknown, it is impossible to say whether it is sufficiently nonsymmetrical to produce the orientation effect. There is no evidence that the colored substance becomes oriented by whatever structural organization exists in the proteins tested. Commoner (*11*) found that the extinction due to anthocyanins and flavones dissolved in intracellular fluid vacuoles is proportional to the vacuole thickness. In this case, the orientation effect is not expected, since the absorbing substance is in solution and therefore completely unoriented. It should be noted that both of these studies test only Lambert's law (linear relation between *E* and sample thickness). The relation of *E* to the number of molecules per unit sample thickness was not determined.

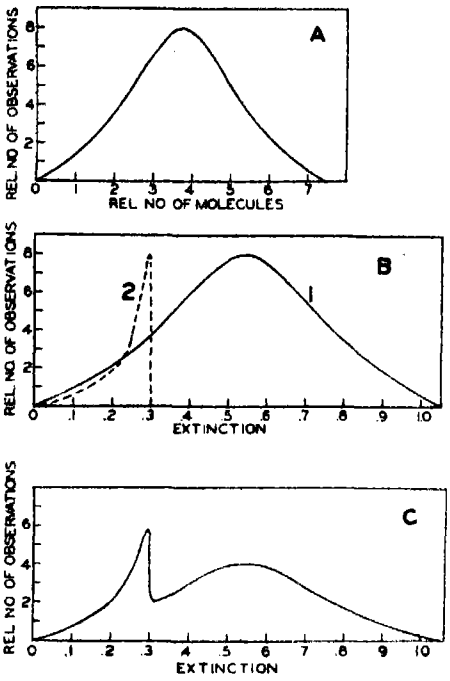

FIG. 3. The effect of orientation on the distribution frequency of extinction values. Fig. 3A is an arbitrarily drawn normal distribution curve for the actual number of nucleic acid molecules in a significantly large population of similar cellular structures. Fig. 3B shows the distribution curves for the extinction values calculated from the relative number of molecules according to the *E* vs. *N* equation for unoriented material (solid line) and oriented material (broken line). Fig. 3C is the distribution curve expected from a population containing equal numbers of oriented and unoriented objects.

One of Caspersson's papers (*5*) does include a table relating *E* at 257 mμ to the thickness of nuclei of *Gomphocerus* spermatocytes in various stages of prophase. These data have been plotted in Fig. 2, and strikingly fail to follow the Beer-Lambert laws. Indeed, the extinction appears to be inversely proportional to the sample thickness.

In the absence of experimental demonstration that the extinction resulting from the nucleic acids of cell structures is actually proportional to the number of molecules scanned, the validity of interpreting such measurements according to the Beer-Lambert law remains an open question. From certain of the extinction data in the literature, it is possible, however, to obtain an indirect test of the linearity of the *E* to *N* relationship. Although this method cannot be applied to all the available extinction data, the results obtained from those cases susceptible to this type of analysis suggest that the orientation effect may play an important role in determining intracellular extinctions due to nucleic acids.

This analysis is derived from a consideration of the curve relating *E* to *N* for the case of fully oriented nucleic acid molecules. (See Fig. 1 of paper *12*, page 43.) This curve shows that *all* oriented objects containing more than a relatively small number of nucleic acid molecules yield the value $E = 0.3$. Since all such objects give the same *E* value, regardless of nucleic acid content, it is to be expected that the frequency distribution of *E* values for a significantly large group of structures containing nucleic acid will be distorted by this phenomenon.

This is illustrated in Fig. 3. Assume that in any large population of cytological structures, the *actual* nucleic acid content (*N*) of each object in the group follows some normal Gaussian distribution curve. An example of such a curve, arbitrarily drawn, is shown in Fig. 3A. Now if this population of objects is examined spectrophotometrically, the *E* values obtained will yield a frequency curve *the shape of which depends on whether or not the objects contain oriented material.* If all objects in the population are unoriented, *E* is proportional to *N* for all values of *N*. Curve 1 of Fig. 3B is the frequency distribution of the *E* values calculated from the population shown in Fig. 3A, according to this proportionality.

On the other hand, if the whole population is composed of fully oriented structures, E is proportional not to N but to the expression $0.3\text{-}\log_{10}(e^{-\epsilon N}+1)$.[4] If E values are calculated from the N values of curve 3A according to this relationship, and plotted against the corresponding frequency, the distribution curve 2 of Fig. 3B is obtained. It is impossible for such a population to yield any E values above 0.3. If the population contains equal proportions of unoriented and fully oriented structures, the distribution curve shown in Fig. 3C will result (obtained by adding curves 1 and 2).

Fig. 3C shows *that if a significant fraction of a* population of cytological elements contains fully oriented nucleic acid molecules, a rather unusual type of frequency curve will be found for the E values obtained. There will be a tendency for the values between $E=0.2$ and $E=0.3$ to predominate, and the frequency of observations will drop sharply as E rises above 0.3. At higher E values a secondary maximum may appear. If the proportion of oriented objects is very low, this second maximum may be the dominant one, but in any case the curve shows an unusual number of values between 0.2 and 0.3, with a sharp drop just above this range.

This general relationship will not be altered by differences in the direction from which a cytological structure is viewed, for as shown above, the value of $E=0.3$ is limiting, regardless of the direction of the incident beam. If the assumption made previously, that the absorption at 260 mμ is due to a distinctive axis, is not true, then the relative frequency with which values around 0.3 would occur would be reduced. However, values in the range $E=0.2$–0.3 would still occur with an unusual frequency, and the qualitative effect on the distribution frequency will not be altered.

This type of analysis can be applied to extinctions obtained from cell structures if the following conditions are met: (1) The data must comprise a significantly large series of extinction measurements made on similar structures, and (2) the size of the field scanned must be so small as to cover a homogeneous area within the structure (if the field is large, differences in the spatial organization of various areas included in it may obscure the orientation effect). If such data yield frequency distributions (i.e., of E values) which are distorted by a predominance of values in the range $E=0.2$–0.3, it is suggested that the group of structures examined contain a significant number of objects with oriented nucleic acid. The E values obtained in these sets of data are therefore not necessarily proportional to nucleic acid content.

The method is applicable to the following published studies on extinctions due to cellular nucleic acids, all of which are based on scanning areas of the order of 1 square micron and include at least 29 measurements on similar material: Thorell (*32*), 132 E values for erythroblasts; Thorell, Bing, and Fagraeus (*33*), 117 E values for plasmacytes; Hydèn and Hartelius (*18*), 30 E values for normal rabbit neurones, and 28 values for neurones of animals treated with malononitrile; Hydèn (*17*), 46 E values for rabbit neurones; Caspersson and Santesson (*9*), 30 E values for various tumor cells; Caspersson (*6*), 29 E values for various regions of nuclei and chromosomes.[5] Details concerning the conditions of these measurements are given in Table 1.

TABLE 1

SOURCE OF DATA PLOTTED IN FIGS. 4 AND 5

Reference	Type of cell	Thickness in μ	Condition	No. of extinction values at 257–260 mμ		
				cytoplasm	nucleus	total
Thorell (*32*)	Rabbit erythroblasts	10–16	living & fixed	143	8	151
Thorell, Bing, and Fragaeus (*33*)	Rabbit plasmacytes	10–16	living	117	0	117
Hyden (*17*)	Rabbit neurones	5	fixed	28	25	53
Hydèn and Hartelius (*18*)	Rabbit neurones—normal and malononitrile-treated	5–10	fixed	58	0	58
Caspersson (*6*)	Insect salivary gland cells	2–3	fixed	0	29*	29
Caspersson and Santesson (*9*)	Tumor cells	5	fixed	22	8	30

* Includes 16 readings on chromosome structures, 3 on nuclear sap, 10 on nucleoli.

The frequency distributions obtained from the data presented in each of these studies are shown in Figs. 4 and 5. The extinction values were taken from tables published in these studies, or read off the published absorption spectra. The tabular values are for extinctions at 257 mμ; the other values are for 260 mμ, at which the absorption spectra usually indicate a measured point.

Of the seven sets of measurements, three (Figs. 4B, 4C, and 5, solid curve) yield distribution curves which show definite maxima at $E=0.2$–0.3. One curve (Fig. 4D) which shows a maximum at this range is not significant in itself because of the smallness of the population, but is presented for the sake of completeness. Two sets of data (Figs. 4A and 5, broken curve) show maxima at *E* values significantly greater than 0.3. The set of data on nuclear structures (Fig. 4E), while too small to be statistically significant, shows a tendency for *E* values less than 0.3 to predominate.

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[4] ϵ = absorption coefficient per molecule.

[5] Consideration of a significantly large set of measurements of neurones by Gersh and Bodian (*15*) has been excluded because the scanning area used was so large as to include a heterogeneous section of the cell.

The occurrence of several sets of measurements with well-defined maxima at 0.3 suggest that the orientation effect has probably influenced the values obtained. It is, of course, possible that these maxima reflect actual nucleic acid contents (unoriented) which correspond to the extinction of 0.3, and that the occurrence of this particular number of nucleic acid molecules in the cytoplasm of erythroblasts varying in thickness from 10–16 μ, in sections of neurones 5–10 μ thick, and in 5-μ sections of various tumor cells is purely fortuitous.

Detailed analysis of these data suggest that the latter explanation is not admissible, and that the maxima shown in *all* the distribution curves can be more reasonably accounted for by the orientation effect than by actual differences in the nucleic acid content of the objects studied.

In the first place, it is necessary to consider the thickness of the materials studied. If the Beer-Lambert law is followed, the modal extinctions would be expected to increase with increasing thickness, unless differences in nucleic acid content just happened to cancel out this effect. Actually, as can be seen from Table 1, the value $E = 0.3$ tends to be limiting despite rather large variations in thickness of the materials studied. The four sets of data yielding maxima at 0.3 were obtained from material 5 μ, 5 μ, 5–10 μ, and 10–16 μ respectively. The measurements made on the thinnest sections (nuclear structures of 2 μ thickness) give the only modal *E* value which is less than 0.3. These observations conform with the relationships expected from the orientation effect. In oriented material *E* can vary with *N* only when the number of molecules contained in the object is so low as to give extinctions less than about 0.3; with increasing values of *N* (e.g., due to increasing thickness of samples) *E* remains at the limit of 0.3 imposed by the orientation phenomenon.

Consideration of the measurements made on plasma cells, which show a modal *E* value of 0.5, provides further evidence on the orientation effect, and suggests that the optical properties of the nucleic acids in undifferentiated cytoplasm are largely dependent on whether or not the cell studied is living or dead.

The plasmacytes (Fig. 4A) represent the only group of material comprised of cells which were apparently alive at the time of measurement. The cells

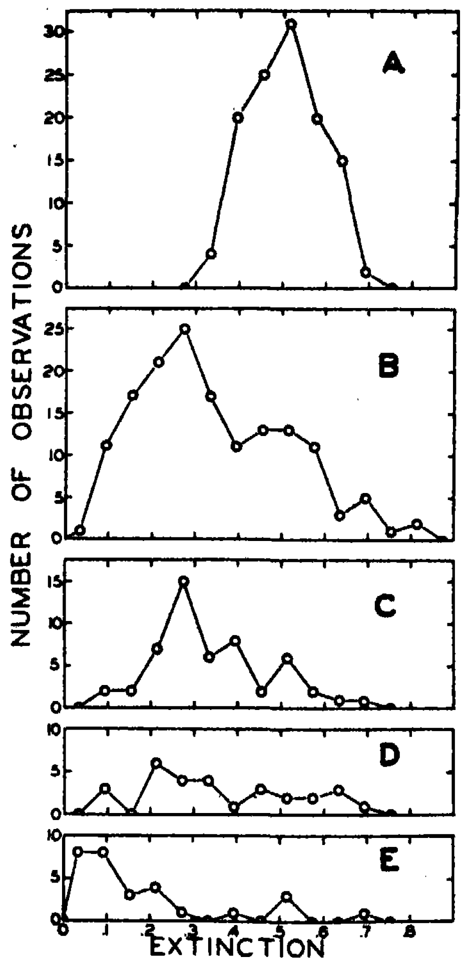

FIG. 4. Distribution frequencies for the extinctions at 257–260 mμ given by various cytological structures. See Table 1 for details of the conditions for measurements. A—Living rabbit plasmacytes (data taken from reference *33*); B—an apparently mixed population of living and dead rabbit erythroblasts (data taken from reference *32*); C—rabbit neurones, fixed (data taken from reference *17*); D—various tumor cells, fixed (data taken from reference *9*); E—various nuclear structures, fixed (data taken from reference *6*).

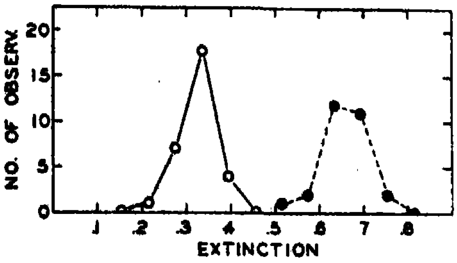

FIG. 5. Distribution frequencies for the extinctions at 257–200 mμ given by neurones from normal rabbits (solid line) and rabbits treated with malononitrile (broken line). (Data taken from reference *18*.) See Table 1 for further details.

used were taken from rabbit blood and mounted in saline, and it is common experience that such cells readily survive in this medium. Furthermore, the authors indicate that special care was taken to avoid the killing effect of long exposures to ultraviolet light during the measurements.

The distribution yielded by these surviving cells is a relatively simple curve with a single peak at about 0.5. Since this value is greater than 0.3, and since the predominance of values in the range of 0.2 to 0.3 expected from the orientation effect is lacking, these data suggest that *the cytoplasmic nucleic acids of living plasma cells are largely unoriented.*

The significance of this observation is amplified by the comparison between the ultraviolet absorption of living and dead cells reported by Larionov and Brumberg (*20*). Using a new reflecting objective which made it possible to focus with visible light, these workers avoided the ultraviolet damage incident to most measurements made with conventional ultraviolet objectives. They found that the cytoplasm of living fibroblasts shows a relatively high absorption at 260 mμ, but that it drops sharply when the cells are killed by exposure to ultraviolet light, or by other means. The absorption of living nuclei, however, was low and increased significantly when the cell died. They suggest that the low absorption usually reported for cytoplasm stems from the fact that most measurements have been made on cells killed by fixation or by exposure to ultraviolet light during the experiment.

These results have been confirmed by Ris and Mirsky (*26*), who found that photographs of living chick fibroblasts taken at 2537 A showed strong absorption in the cytoplasm, which decreased markedly when the same cells were killed by exposure to ultraviolet light. These authors suggest that the loss of ultraviolet absorption on death is a result of "ribosenucleic acid leaking out of the disintegrating cell." This explanation seems doubtful, however, for the very large nucleic acid molecules would diffuse slowly, and as pointed out both by Larionov and Brumberg and by Ris and Mirsky, a corresponding loss of nucleic acid from dead nuclei does not occur.

On the basis of the orientation phenomenon an alternative explanation can be offered for this effect—namely, that the loss in absorption at 260 mμ results from the orientation of cytoplasmic nucleic acids which occurs at death of the cell. This would cause the extinctions to fall to the limit of 0.3 despite the fact that the cytoplasm might contain sufficient nucleic acid to give higher extinctions in the unoriented state. This view is supported by observations (*27*) that sharp increases in the birefringence of cytoplasm may be induced by fixing agents.

The bimodality of the distribution curve for erythroblasts (Fig. 4B) may be explained similarly. The predominance of values in the range 0.2 to 0.3 suggests that a large fraction of the measured cells contained oriented cytoplasmic nucleic acids. But the appearance of the secondary maximum at 0.5 would indicate that at least some of the cells contained unoriented cytoplasmic nucleic acids. It would be expected, therefore, that the population of erythroblasts consisted of a mixture of living and dead cells at the time of measurement (cf. Fig. 3C).

The nature and treatment of the erythroblasts is in accord with this expectation. Thorell reports that the erythroblasts were obtained from living bone marrow, teased out in saline, and mounted on slides under cover glasses sealed with vaseline to prevent drying. Although care was taken to avoid killing by undue exposure to ultraviolet light, the survival time of teased-out bone marrow cells in a thin sealed film is probably limited; and one would anticipate that some fraction of the cells were dead when measured. Furthermore, some of Thorell's preparations were treated with lanthanum acetate to precipitate the nucleic acids and provide a "more stable preparation" (page 46, reference *32*). Since such cells were dead, this treatment apparently contributed to the size of the nonliving fraction of the population. The bimodal character of the frequency distribution given by the erythroblasts may therefore reflect the fact that some of the cells measured were living (unoriented cytoplasmic nucleic acids, modal $E = 0.5$) and others dead (oriented cytoplasmic nucleic acids, modal $E = 0.3$).

The data are thus consistent with the idea that the nucleic acids in the undifferentiated cytoplasm of living erythroblasts and plasmocytes are unoriented, therefore yielding extinction values which are relatively high and probably proportional to the actual nucleic acid content. On the other hand, the cytoplasmic nucleic acids of dead cells tend to become oriented, thus yielding extinction values which fail to exceed 0.3 and so are independent of nucleic acid contents which would, if unoriented, give higher E values.

It is possible that the changes in the ultraviolet absorption of nuclei on death which have been noted (*20, 24, 26*) may be due to similar variations in the degree of orientation imposed on the nucleic acids. However, the available data are too incomplete to provide an adequate basis for an analysis similar to the one outlined, and the question must remain open at present.

The increase in extinction at 260 mμ of neurones from rabbits treated with malononitrile (Fig. 5) is interpreted by Hydén and Hartelius (*18*) as representing a proportional rise in the nucleic acid content of these cells. However, the ultraviolet photographs of the treated cells show that malononitrile causes a marked change in the configuration of the structures, which are apparently rich in nucleic acid (the Nissl bodies). In the untreated cells, the Nissl substance has the "tigroid" appearance of more or less clumped material. Cells from malononitrile-treated animals, on the other hand, show a structureless dense mass diffusely spread through the cytoplasm. It seems likely, therefore, that the treatment induces a significant change in the degree of aggregation of the Nissl substance. Since the aggregated (normal) form of Nissl substance gives modal *E* values of about 0.3, there is reason to believe that it may contain oriented nucleic acids. It seems possible that the increase in the modal extinctions exhibited by the treated material may be a result of disaggregation (and the concomitant disorientation) of nucleic acids caused by malononitrile. The rise in extinction induced by the treatment would not reflect an actual increase in nucleic acid content.

This analysis suggests that differences between the extinction at 260 mμ of cellular structures may frequently arise from variations in the degree of orientation of their constituent nucleic acids, rather than from real differences in nucleic acid content. Thus, where structures differ considerably in the degree of orientation of their nucleic acids, failure to consider this factor may lead to large errors in interpretation.

For example, a study of the extinction of nuclei in various stages of spermatogenesis in the locust has led to the conclusion (*4*) that a "considerable amount of nucleic acid disappears from the nucleus" as the sperm ripens. The reduction in extinction is evident from ultraviolet photographs (reference *4*, Figs. 79, 80) in which spermatocytes show considerably darker nuclei than do neighboring sperm cells. However, the two cell types also differ greatly in the degree of orientation of their nuclear material. During sperm formation, the spherical nucleus of the spermatocyte stretches into the elongated spindle form which characterizes the mature sperm. Optical studies (*23, 27*) show that the birefringence of spermatid nuclei increases in parallel with elongation, and that the nucleic acid molecules thereby become markedly oriented. This orientation has been directly demonstrated (*7*) in photographs of sperm bundles taken with ultraviolet light (260 mμ) of varying planes of polarization. The material is highly dichroic, yielding a maximum extinction when the plane of polarization is perpendicular to the long axis of the sperm nuclei. It seems likely, therefore, that the reduction in ultraviolet extinction accompanying the elongation and maturation of the sperm nuclei is not due to "loss" of nucleic acid, but is rather a consequence of the orientation which is imposed on the nuclear material during spermatogenesis.

A similar case is the determination of the extinction of muscle fibers (*10*). The *E* values for isotropic segments of striated muscle fibers are significantly higher than those given by neighboring anisotropic segments. Since the absorption at 257 mμ is probably related to the adenylic acid (and its phosphorylated compounds) of the muscle, this observation led to the conclusion that most of the adenine compounds are localized in the isotropic segments.

An alternative interpretation of these data may be offered. The anisotropy of the muscle fibers seems to be due to oriented micelles of myosin. The myosin fibers are also the locus of the adenosine triphosphatase activity of the muscle, and the formation of a complex between myosin and adenosine triphosphate has been demonstrated. It seems possible that a significant part of the nucleotide in muscle fibers will be oriented by attachment to myosin wherever this protein is itself oriented (i.e., in the anisotropic bands). Hence the isotropic bands' showing greater extinctions than the anisotropic bands may result from the fact that the adenine compounds tend to be more strongly oriented in the latter, rather than from any difference in concentration.

The foregoing analysis suggests that the orientation effect probably is important in determining the extinctions given by cytological structures at 257–260 mμ. The ultraviolet absorption of such structures cannot be evaluated by the simple application of the Beer-Lambert laws. The interpretation of intracellular extinction values at 257–260 mμ seems to be subject to the following reservations:

1) Where part or all of the nucleic acid in a structure is oriented in three dimensions, *E* is not proportional to the nucleic acid content unless *E* is smaller than about 0.1–0.2.

2) In general, the *E* values yielded by oriented aggregates may be considerably smaller than the *E* value which the same number of nucleic acid molecules would yield if not oriented; but this relationship is reversed when very low nucleic acid contents are encountered. For the case of complete orientation, *E* cannot rise above 0.3, regardless of the number of nucleic acid molecules scanned.

3) If the orientation effect occurs, it is not possible to calculate the nucleic acid content of a cell structure by comparing its extinction with the extinction given by a known number of nucleic acid molecules in solution.

4) In comparing two cytological structures, it would appear impossible to obtain a ratio of their nu-

cleic acid contents from the ratio of their extinction values (for equal thicknesses) unless it can be shown that the same degree of orientation occurs in both structures.

These reservations apply to the interpretation of qualitative observations, such as the darkness of ultraviolet photographs, as well as to the treatment of quantitative photoelectrical measurements.

The analysis presented is suggestive rather than conclusive. It does, however, indicate that the entire subject needs to be more closely scrutinized before it is possible to accept the assumptions on which many studies of ultraviolet absorption are based, or to look upon the resulting conclusions (*8*) as a sound foundation for theories of protein metabolism, gene action, and the special roles of the nucleic acids.

The need for new data is apparent. The location of the absorption axes of the nitrogen bases must be known if the optical behavior of nucleic acids is to be fully understood. Determination of dichroism at 260 mμ could yield precise information on the orientation of nucleic acids. The validity of Lambert's law could be determined by studying the extinctions of various thicknesses of the same or similar structures. Some way needs to be found for testing Beer's law within cells. The optical changes which occur on the death of the cell seem to be sufficiently important to warrant much attention.

Structural considerations other than orientation proper may be related to the light-absorbing powers of cellular substances. The work of Sheppard, Scheibe (see reference *12* for references), and others shows that polymerization and simple aggregation may cause serious changes in the absorption characteristics of certain substances. Such effects may also induce anomalous behavior in nucleic acid solutions and may account for the recent observation (*19*) that polymerization of nucleic acid causes a significant change in extinction coefficient.

The optical consequences of orientation of cellular materials may play an important role in determining the properties of photochemical systems in living cells. There is evidence (*29*) that the degree of aggregation of some substances may determine the appearance of new absorption maxima which result from intermolecular electron transfers. The fundamental importance of such molecular behavior in living systems has been suggested by the work of Szent-Györgyi (*31*).

The value of the application of optical methods to cellular biology is apparent from the important results already achieved. It may not be amiss to suggest, however, that the full use of this tool depends largely on an understanding that we are dealing with a complicated and dynamic state of matter, in which relationships inconsequential in simpler systems become of decisive importance. Close attention to the special and uncommon optical properties of living cells may be more revealing than their similarities to the states of matter which are dead.

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TECHNICAL PAPERS

Chromosome Numbers for Two Species of Mexican Commelinaceae

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Bailey Hortorium at Cornell University, and
University of California

Although the Commelinaceae have provided classic material for cytological and cytotaxonomic studies (*1–3*), sufficient material has never been available for thorough treatment of the Central American representatives of the family. The authors report the following collections from Mexico:

Tradescantia iridescens Booth ex Lindl. $n = 6$. Borders of oak woods near Real del Monte, State of Hidalgo, Mexico. Altitude, 8500–8700 ft. Aug. 1, 1948. *H. E. Moore, Jr., C. E. Wood, Jr., E. Atchison, 4247.*

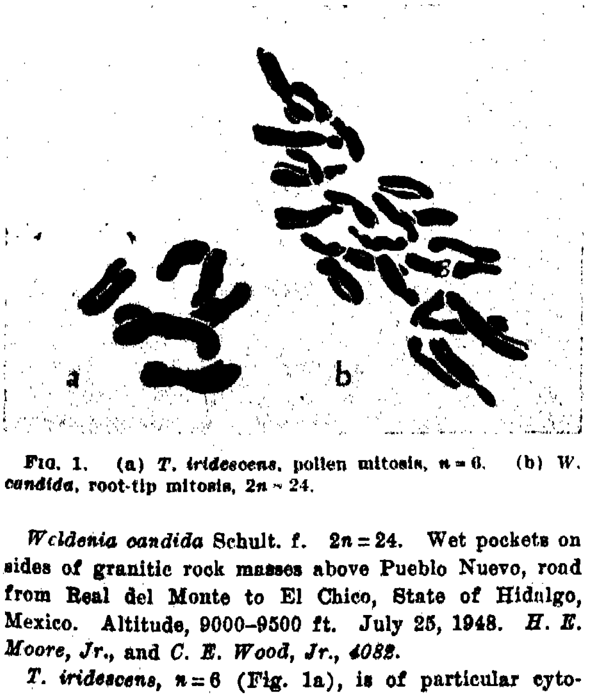

FIG. 1. (a) *T. iridescens*, pollen mitosis, $n = 6$. (b) *W. candida*, root-tip mitosis, $2n = 24$.

Weldenia candida Schult. f. $2n = 24$. Wet pockets on sides of granitic rock masses above Pueblo Nuevo, road from Real del Monte to El Chico, State of Hidalgo, Mexico. Altitude, 9000–9500 ft. July 25, 1948. *H. E. Moore, Jr.*, and *C. E. Wood, Jr., 4082.*

T. iridescens, $n = 6$ (Fig. 1a), is of particular cytotaxonomic interest since it is the first diploid species to be reported among the Mexican tradescantias. The species is apparently endemic to the area around Real del Monte; it is known only from the type collection, *H. E. Moore, Jr., 3111*, and the collection cited above. *W. candida*, $2n = 24$ (Fig. 1b) is found in the alpine regions of central Mexico and Guatemala.

Specimens will be deposited in the Bailey Hortorium, Gray Herbarium, and Museum of the Department of Agriculture, San Jacinto, D.F., Mexico.

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The Application of the Beer-Lambert Law to Optically Anisotropic Systems

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The determination of the concentrations of various substances in cell structures by the measurement of their absorption spectra in the cell is becoming a widely used experimental procedure (*3, 4, 6, 11*). Caspersson and his co-workers (*3*), for example, have made quantitative estimates of the relative, and sometimes absolute, concentrations of nucleic acids, proteins, and other substances in cells by the use of this technique.

The quantitative evalution of such microspectrophotometric measurements is dependent on the validity of the assumption that the decrease in intensity of a beam of monochromatic light on passing through a cell structure is quantitatively related to the number of molecules of absorbing material in the path of the light beam. Recognizing this limitation, Caspersson has shown (*1*) that in the passage of a light beam through microheterogeneous structures such as cytoplasm, the losses due to nonabsorption processes are relatively small and calculable. This consideration of nonspecific light losses, however, does not accomplish the complete validation of intracellular extinction measurements as an index of concentration. Even though the difference in intensities of the incident and transmitted light beams may actually be due to absorption of photons by a given cell constituent, it is still necessary to know the quantitative relationship between the amount of light absorbed and the number of molecules in the path of the light beam. Usually it is assumed that this relationship is described by the Beer-Lambert law, $E = \log I_0/I = \varepsilon cd$.[1]

This law may be derived using the following assumptions: (a) that a single molecular species is absorbing the light, and (b) that variations in concentration do not affect the interactions either between solute molecules or between solute and solvent in such a way that the probability of absorption of a light quantum by a single solute molecule is changed. No published data are available on the applicability of the Beer-Lambert law to light absorption by molecules in the complicated states of aggregation characteristic of cell structures. Since *interpretations of absorption measurements* (e.g., by Caspersson and co-workers) are based on the above proportionality between c and E, and because the theoretical conclusions derived from them have been of considerable interest to biologists, it is necessary to consider to what degree the Beer-Lambert law is valid for the actual conditions of intracellular measurements. It is the purpose of this paper to examine one of these conditions—the orientation of the absorbing molecules—for its effect on the validity of the Beer-Lambert law.

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[1] E = extinction, I_0 = intensity of the incident light beam, I = intensity of the transmitted beam, c = concentration of absorbing material in moles/liter, d = thickness of the sample in cm, and ε = molar extinction coefficient.

It has been suggested *(9)* that the absorption by a molecule of a light quantum of appropriate energy is due to the excitation of electronic oscillations in the molecule. Except in the case of an optically symmetrical molecule, the probability of absorption of a given quantum depends on the spatial relationship between the molecule and the electric vector of the incident light. Specifically, this probability is proportional to $\cos^2 \theta$, where θ is the angle between the direction of the electronic oscillation (an optical axis of the molecule) and the electric vector of the light beam. Consequently, the probability of absorption is zero when the electric vector is perpendicular to the optical axis and increases to a maximum as the angle becomes zero. The effect of orientation on the absorption spectra of optically anisotropic molecules has been studied by Weigert *(16)*, Taylor *(15)*, Scheibe *(12)*, Lewis and co-workers *(10)*, Jelley *(7)*, and Sheppard *(14)*. If such molecules are examined with unpolarized light in dilute solution they show no unusual optical properties. In this case the electric vectors of the light beam are randomly distributed in a plane at right angles to the beam and the dissolved molecules are oriented at random. On the other hand, if the optically anisotropic molecules are oriented and examined with plane polarized light, then they exhibit dichroism: the extinction varies with the orientation of the plane of polarization. Caspersson *(2)* has shown that partially oriented films of thymonucleic acid exhibit this behavior at 265 mμ. Furthermore, the work of Schmidt *(13)*, Frey-Wyssling *(5)*, and others indicates that the nucleic acids in cell structures may be oriented to a greater or lesser degree. The same is true of other optically anisotropic substances occurring in cell structures.

Since practically all cellular extinction values are obtained with unpolarized light, one might expect that the above factor would not interfere with the measurements. As we shall show below, such an expectation is unwarranted. A consideration of the quantitative relationship between the number of molecules in the light beam and the extinction (E) shows that this function is dependent on the degree of orientation of the optical axes of the molecules *even when the measurements are made with unpolarized light*.

We shall limit our considerations to a molecule in which there is possible a transition which corresponds to a distinctive axis. In other words, the molecule must have sufficiently low symmetry so that it has one optical axis which is different from all of the other possible optical axes. The cyanine dyes fall into this category; the optical axis corresponding to the main absorption band of longest wavelength coincides with the largest dimension of the molecule *(9)*. Malachite green also falls into this group. It has three different optical axes; one corresponds to the absorption band at 625 mμ and another to the band at 423 mμ *(8)*. It should be noted that crystal violet also has three optical axes, but that two of them are identical. The discussion which follows would pertain only to the one axis which is distinctive. The purines and pyrimidines would, like malachite green, have three different optical axes. The following comments apply here to absorption corresponding to any one axis.

The relationships between the extinction (E) for *unpolarized light* and the number of molecules of the type described above have been derived for three degrees of *orientation of a given optical axis relative to the light* beam, as follows:[3]

Case I. Completely random orientation of the optical axes. In this case the relationship is

$$\log_e \frac{I_0}{I} = \frac{\alpha N}{3}, \text{ or } E = \frac{\alpha N}{3 \times 2.303}.^{4}$$

Case II. The optical axes all lie in a stack of planes with each plane perpendicular to the light beam, but the axes in each plane are randomly oriented. Here the relationship takes the form

$$\log_e \frac{I_0}{I} = \frac{\alpha N}{2}, \text{ or } E = \frac{\alpha N}{2 \times 2.303}.$$

Case III. The optical axes are all parallel and the light beam is in a plane perpendicular to these axes. The *relationship now becomes* $\log_e \frac{I_0}{2I - I_0} = \alpha N$, *or* $E = 0.3 - \log_e (e^{-\alpha N} + 1)$.

These three functions are plotted in Fig. 1. It can be seen that for the case of a completely oriented group of molecules (Curve 3, Case III) E is approximately proportional to the number of molecules only at extinction values less than 0.15. Above this value the slope of the curve changes until it approaches zero, so that as E approaches 0.3 the amount of light absorbed becomes independent of the number of molecules. In other words, if a completely oriented aggregate of optically anisotropic molecules such as we have described above is examined with monochromatic unpolarized light, then the amount of incident light absorbed can never be above 50%. This same type of behavior is exhibited by a sheet of Polaroid. If we consider a group of optically anisotropic molecules whose orientation corresponds to Case II (see Curve 2, Fig. 1), the relationship between E and N is a linear one, but not quantitatively the same as if the molecules were *randomly oriented*. For a given number of molecules, E for random orientation in a plane is 50% greater than

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[3] We are indebted to Prof. S. I. Weissman for the derivation of these equations and for many helpful discussions of the problem.

[4] In these equations N = the number of molecules per unit area of light beam, and α = the absorption coefficient per molecule when the optical axis of the molecule and the electric vector of the light beam are parallel.

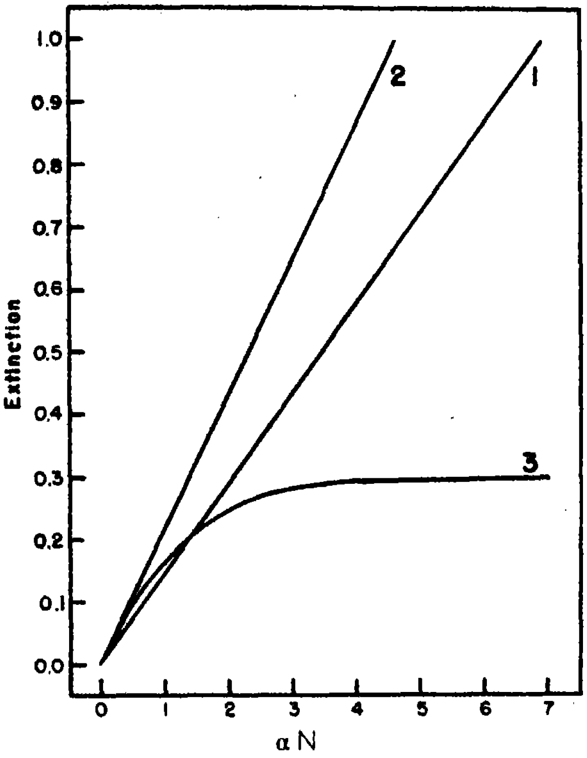

FIG. 1.

E for random orientation in three dimensions. If similar calculations are made for samples in which only a part of the absorbing molecules are fully oriented, one obtains curves lying between Curves 1 and 3 (Fig. 1). These considerations lead us to the conclusion that the Beer-Lambert law must be applied with caution to groups of optically anisotropic molecules which may be more or less oriented.

As previously noted, there is evidence for some degree of orientation in practically all cytological structures other than liquid vacuoles (*5, 13*). Further, most biologically important molecules are optically anisotropic. Hence the assumption that the concentration of such an absorbing substance in a cell structure can be calculated from the ratio of its extinction value to the extinction of a given number of molecules of the substance in solution is not valid. Furthermore, unless the orientation of the optical axes in two cytological structures is identical, the assumption that the ratio of their extinctions per unit thickness is equal to the ratio of their content of such absorbing material is also invalid. Thus, in cytological absorption measurements made with unpolarized light, variations in extinction values may arise from differences in the degree of orientation rather than from differences in content of any specific substance. It seems clear that the entire problem of interpreting intracellular extinction measurements needs to be reexamined with the realization that one is dealing not with true solutions but with oriented aggregates of molecules.

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Opalescence of Serum after Total Body X-Irradiation as a Prognostic Sign of Death[1]

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During an investigation of the clotting reaction of blood after irradiation with 200-kv X-rays, the author noted the appearance of a marked opalescence in the serum and plasma of rabbits, which subsequently died a few days after exposure to a single lethal dose of total body irradiation. This opalescence appeared within 24 hr following the exposure to radiation. In all cases, it disappeared completely 72 hr after exposure. A review of the literature has failed to reveal any mention of this phenomenon.

Rabbits of the New Zealand white strain were given over the total body single doses of 200 kv X-irradiation, calibrated in air by a Victoreen ionization chamber. Dosage ranged from 200 to 1000 roentgens (r). Blood samples were obtained by cardiac puncture before radiation and at various intervals after radiation (up to 30 days). Serum was obtained from the clotted blood and plasma was obtained by centrifugation of either citrated or oxalated blood. In all cases the opalescence, when present, was noted in both serum and plasma.

The opalescence was noticeable as a pearly white tint homogeneously distributed throughout the sample. Various degrees of intensity have occurred and can be classified as marked, moderate, and slight, as shown in Fig. 1. All animals showing marked opalescence died as a

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[1] Portions of this study were aided by the Atomic Energy Commission and U. S. Navy Contract N6ori-111, Task Order III Project No. NR 171–138.

[2] The author wishes to thank Dr. John H. Lawrence and Dr. Hardin Jones for their valuable advice and assistance.

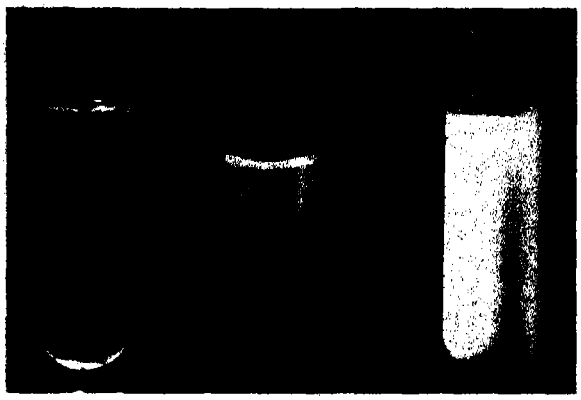

FIG. 1. Tube at left shows clear serum as found before irradiation of rabbit. Center tube shows moderately opalescent serum (rabbit No. 16, 24 hr after irradiation; animal sacrificed 34 days after irradiation). Tube at right shows *markedly opalescent serum (rabbit No. 15, 24 hr after irradiation; died a few hours later).*

result of radiation within 5 days following exposure. Animals having no opalescence or opalescence to a lesser degree usually survived the radiation for at least 30 days, unless death occurred from other causes.

If opalescence occurred it was prominent 24 hr after radiation, and completely disappeared 3 days after radiation in all cases. No relation was noted between its occurrence and diet or fasting. Serum obtained either with or without fasting (20 hr) was always clear except for the opalescence following radiation. On the other hand, opalescence has been found in both fasting and nonfasting animals after radiation.

In the present series of rabbits, there is no relation between opalescence and changes in weight, white cell count, lymphocyte, or heterophile count 24 hr after radiation. The absence of any red pigmentation in opalescent serum tends to rule out erythrocyte hemolysis as a causative factor. Also, there seems to be no direct relation between opalescence and radiation dose rate. Table 1 lists data pertinent to this report. Detailed coagulation and hematological studies on these animals will be reported subsequently.

Studies are in progress with the collaboration of Dr. John Gofman to determine the chemical nature of opalescence. The opalescence can be eliminated from serum by acetone and ether extraction according to the method described by Blix (*1*). In low speed ultracentrifugation, material that is responsible at least in part for the opalescence rises to the top, to leave a clear infranatant solution.

At present, there is no clear explanation of the mechanism by which radiation produces this opalescence. In view of its apparent relation to death, the phenomenon *may not only provide a valuable early measurement of* the effect of acute exposure to radiation, but may lead to further knowledge concerning the nature of radiation sickness and its lethal mechanisms.

TABLE 1

DOSAGE OF TOTAL BODY IRRADIATION, APPEARANCE OF SERUM OPALESCENCE, SURVIVAL TIME, LYMPHOCYTE, AND HETEROPHILE COUNTS IN RABBITS

Rabbit No.	Radiation dose	Dose rate	Opalescence* of serum 24 hr after radiation	Days of survival after radiation			Lymphocyte count		Heterophile count	
				Died from radiation	Died other causes	Sacrificed	Before radiation	24 hr after radiation	Before radiation	24 hr after radiation
	r	r/min								
2	200	25.8	None	..	..	28†	4700	1960	4610	2640
1	400	25.8	None	..	..	28†	5560	1030	2570	3180
1	400	23.2	None	..	..	34	2060	840	3230	5810
2	400	23.2	None	..	..	34	1920	900	2880	5346
3	800	47	None	..	..	32	8360	240	2640	7520
7	800	24	Marked	5	..	..	9510	1020	5430	7310
8	800	52	Marked	2	..	..	6080	660	1870	10120
10	800	52	Slight	..	16‡	..	6770	520	1850	9460
11	800	52	Slight	..	..	31	8450	970	1180	9400
12	800	54	None	..	9§	..	2840	150	2440	4980
13	800	54	None	..	..	31	5100	470	2100	3480
5	1000	24	Marked	5	..	..	5740	250	7760	8050
9	1000	52	None	..	..	30	4710	580	6330	6570
14	1000	43.5	None	..	10‖	..	4820	330	2190	3690
15	1000	43.5	Marked	31 hr	..	..	8500	4520	1800	2810
16	1000	44	Moderate	..	..	35	11400	310	2810	7330
17	1000	44	....	20 hr	..	..	6580	....	2400	.....

* Serum was never opalescent except in the period 24 hr after radiation.

† Not sacrificed; 400 r given on 28th day after first radiation.

‡ Died 20 min after Nembutal. Post-mortem: small right hemothorax; otherwise negative on gross examination.

§ Died within 1 hr after Nembutal and cardiac puncture. Post-mortem: marked gastric dilation with moderate pyloric hypertrophy; otherwise negative on gross examination.

‖ Died ½ hr after cardiac puncture; *marked hemopericardium present; post-mortem otherwise negative; gross examination.*

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An Automatic Analyzer for the Study of Speech in Interaction and in Free Association

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The study of speech (verbal activity) in the interview situation and in free association is being undertaken as a preliminary investigation of the process of psychotherapy. An attempt is being made to determine the relationship between the tempo and distribution of units of speech and the progress of therapy. Further relationships between verbal behavior and other personality characteristics and clinical diagnosis are being investigated. In previous work the verbal and gestural behavior of subjects and patients have been studied by the use of the "interaction chronograph" (*2*). This device records the interaction by having an observer depress a key during periods of activity and release the key during periods of inactivity. In observing an interview two keys were used simultaneously, one to record the activity of each of the participants.

In the close observation of so many fleeting phenomena even the trained observer is faced with a difficult task. The variability of the observer's reaction time, the practice effect, and the effects of fatigue are the major sources of error. The analysis of the record which is done by other workers may be an additional source of error.

In order to obtain more accurate information, an analyzer was designed and built which automatically performs all the operations required for the recording and analysis of verbal activity—thus eliminating the human observer.

The automatic speech analyzer consists of four parts. The first computes the duration of speech and the total number of units of speech (a unit of speech is defined as any period which is separated from the subsequent one by a minimum pause of a certain duration—in these studies, 0.5 sec). The second part of the analyzer classifies the units of speech in terms of their duration in sec, and gives their frequency distribution. The third part records the number of interruptions and classifies them according to which participant in the interview interrupts and which one stops speaking after the interruption. The fourth part is a tape recorder on which the units of speech are recorded. Two complete units, including the four parts described above, are provided for each of the participants in an interview.

The speech of the two persons in the interview is picked up by unidirectional microphones (cardioid type) whose output is fed into speech amplifiers (Fig. 1). The gain of the amplifiers is adjusted so that the imput of the two microphones will not interfere with each other. The output of the amplifiers is rectified and taken through a clipping circuit which maintains the voltage below a certain limiting level. The output of the speech amplifier, after having gone through the clipping circuit, is fed to an adjustable time delay relay[1] (time delay *A* on diagram) which does not drop out unless the pause in speech is at least 0.5 sec.

Thus when the subject begins to speak the relay pulls on, energizes an electromagnetic counter, and starts an electric timer. When the subject stops speaking *and only after the minimum pause mentioned above has elapsed,* the counter completes the counting of one unit and the timer stops. If the minimum pause does not elapse, the counter does not complete the count and the timer goes on timing whatever follows as one period, until the minimum pause occurs. At the end of the whole interview the counter will show the total number of units of speech and the timer will show the total time in speech.

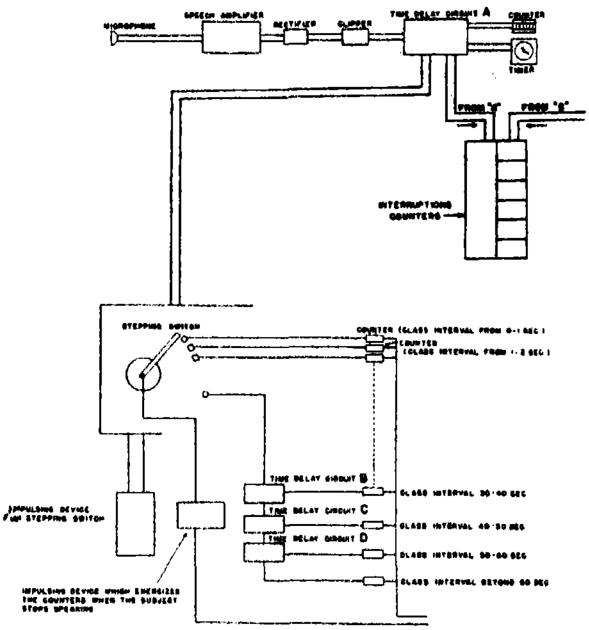

FIG. 1.

The total time in silence is obtained by subtracting the total time in speech from the total duration of the interview. The time delay relay also energizes a pen, which leaves a trace of every period of speech on a paper tape, pulled by a synchronous motor, so that each period of speech can be recorded and studied separately, if desired. Two identical channels including microphone, amplifier, rectifier, clipper circuit, time delay relay, counter, and timer are provided; one for the subject, one for the interviewer.

For the study of variability an apparatus was devised which at the end of the interview shows automatically, on a series of counters, the frequency distribution of the durations of the units of speech. (This is the second part of the complete unit.)

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[1] Certain types of time-delay circuits, like the multivibrator ("flip-flop") type, which is used at present in the apparatus described, eliminate the necessity of using rectifiers and clipper circuit. This type of time-delay circuit was designed and built for us by Hanopol and MacLeod, Charlestown, Massachusetts.

This apparatus consists essentially of (1) a timer which provides a short pulse every second; (2) a stepping relay (or stepping switch); (3) a series of time delay relays, (time delay circuits *B*, *C*, and *D* on diagram); (4) a series of electromagnetic counters.

Every time the subject begins to speak the stepping switch begins to move from contact to contact, in steps of 1 sec, under the control of the impulses emanating each second from the timer, and keeps moving as long as the subject speaks. When the subject stops speaking an impulse goes through the wiper of the stepping switch to a counter, which records that unit of speech as one belonging to a class interval of a fixed duration. The wiper returns to zero and is ready to move up for another unit.

For practical purposes it was convenient to limit the stepping switch to 30 steps. If any period of speech lasts longer than 30 sec, it will be classified in a larger class interval in the following way:

When the wiper of the stepping switch arrives at the *30th* contact it energizes a time delay relay circuit, which in turn energizes a counter which will record a halt in the subject's speaking between 30 and 40 sec after zero time. *If* the subject speaks beyond 40 sec, another time delay circuit will energize another counter which records a halt between 40 and 50 sec, and so on. The last counter will record all the periods of speech which lasted beyond 1 min.

For the study of interruptions a switching and computing system was built which automatically counts the interruptions and classifies them into the following six categories:

1. A begins to speak, B interrupts, A stops
2. A " " " B " B stops
3. A " " " B " both stop
4. B " " " A " A stops
5. B " " " A " B stops
6. B " " " A " both stop

One of the great advantages of this analyzer is that it can be used in the study of any phenomenon distributed in time. It can automatically determine the number of occurrences in a given time, the total duration of a series of individual occurrences, and the frequency distribution of the durations of the events studied. From the frequency distribution the standard deviation can be readily calculated.

In our present work we are adapting this apparatus to the study of speech (verbal activity) as it occurs in the interview situation and in free association during psychotherapy. In studying free association we record the patients' verbal productions on a wire recorder and then play the record back into one of the channels of the automatic speech analyzer.

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Increasing the Efficiency of the Laying Hen

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Mount Hope Farm, Williamstown, Massachusetts

Work has been under way for many years on increasing the efficiency of the hen by increasing the number and size of eggs, and by reducing losses in the laying houses due to disease. In a long-term attack on this problem and using a unique method of measuring gains, we are able to state that the efficiency of the individual hen, measured by the increase in average weight of eggs per hen per year, has risen by 75.4% since 1923. If the decline in losses is taken into account, the increase in efficiency is 106.8%. This increase has been gained through the consistent use of the family method of breeding—an adaptation of Mendelian principles to the peculiarities of quantitative characters. So far as we are able to learn, no other method of breeding has been developed capable of making so much improvement in efficiency.

References 2–5 give results of the application of this method of breeding in other instances. It has been used by poultry breeders of Massachusetts and vicinity with so much success that poultry breeders in all sections of the United States and Canada are adopting it. The method is effective because each pair of parents is judged by the qualities of all their children. Pairs whose children rate highest in the qualities desired by the breeder are given an opportunity to have more children. Meanwhile, a new generation of parents is selected from members of families with the highest ratings. But of this new generation of parents, only those few whose children rate the highest are retained. This process, repeated generation after generation on a sufficiently large scale, has thus far promoted a constantly rising average of those qualities which the breeder seeks to improve.

The improvement in the efficiency of the laying hen made through consistent use of the family method of breeding suggests that when it is applied to other farm animals and to food plants, similar gains in efficiency will result.

The poultry plant at Mount Hope Farm was begun in 1917. Work on improving the efficiency of the hen began in 1918 with the assembling of the best stock available at that time. Once the assembling of stock was completed, the flock was closed and no other stock added. As it was not necessary for the work to be self-supporting, or to provide a livelihood for a farm family, the work could proceed without the handicaps that confront many poultry breeders. Thus it has been possible to use a method of measuring gains which most poultry breeders have not found feasible.

This method, established in 1923, consists in setting aside entire families of full sisters, which are all held—good, bad, and indifferent—for 15 months after the first hatch is placed in the laying houses. Beginning in 1927, these families have come from parents hatched the previous season. These parents are, therefore, not progeny-proved. Records are kept in detail. Management has been maintained as nearly as possible like that in 1923.

TABLE 1

Year*	Average† egg weight in oz	Average number of eggs per hen per year	Average weight in oz of eggs produced by each hen per year
1923	1.85	168	310.8
1929	1.85	220	407.0
1946	2.30	237	545.1‡

* Records begin in the autumn of the year the birds are hatched. 1946 is the last year on which completed records are available.

† Taken during the spring.

‡ The 1948 flock promises to exceed 600 ounces.

The birds are housed in units of 100. The number of pullets in this group has ranged from a low of 300 in some years to a high of 800 in other years. The daughters of parents already proved good are kept in a separate group. Their records are not included in this report.

The average annual egg production of these flocks multiplied by the average egg weight gives the amount of product of each hen. From 1923 to 1929, efforts were concentrated on increasing the number of eggs, the size remaining constant. Then, forced by the demand for larger eggs, efforts were made toward increasing and fixing the size of eggs desired by the trade and toward making such gains in egg number as the inverse correlation between egg size and some of the factors entering into egg number permitted. The results of this work are shown by the averages in Table 1.

As Table 1 shows, the average hen in today's flocks is laying 234.3 oz more eggs than in 1923. This is an increase in efficiency of 75.4%.

Inspection of the table shows that the rate of gain from 1929 to 1946 is about half that from 1923 to 1929. It proved much easier to increase number of eggs, leaving egg size constant, than to combine the desired egg size with high rate of lay and early maturity, but this has finally been accomplished.

The enormous losses in the laying houses from deaths due to disease were not generally recognized when the present method of measuring gains in efficiency was established in 1923. This happened because these losses were obscured by the prevalent practice of culling nonproductive birds. A few years later the New Jersey Agricultural Experiment Station (*1*) stated that losses from death and culling during the year sometimes reached 60%. This was confirmed later by the Ohio Agricultural Experiment Station (*6*). Meanwhile, the losses from deaths in our unculled flocks, under exceptionally high standards of sanitation, were reaching the same amount in some years, thus indicating that culling merely anticipated deaths that would otherwise occur.

TABLE 2

Year	Number of pullets at beginning of year	Number dying during year	% dying
1923	304	138	45.4
1929	399	99	25.0
1946	801	148	18.5

The losses in the laying flocks for the three years of Table 1 are shown in Table 2.

A reduction in mortality increases the efficiency of a poultry plant by permitting it to operate toward maximum capacity. If the plant of 1923 had operated at full capacity for the year, i.e., without deaths, each unit of 100 hens would have produced 31,080 oz of eggs. As the records show that deaths occur at a fairly uniform rate throughout the year, each unit operated with an average of 77 hens for the year, thus producing only 23,932 oz of eggs. In 1946, however, with each unit operating with an average of 90.8 hens, it produced 49,495 oz of eggs—an increase of 25,563 oz, or an increase of 106.8% in the efficiency of the plant over 1923.

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Low Temperature and Survival of Embryonic Tissue

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The effect of low temperature on embryonic tissue has a practical as well as a theoretical interest. Various reports have appeared in the literature on hypothermia in relation to neoplastic tissue (*6, 33, 15*). Preyer (*11*) observed that no further development of the incubating chick occurred after the temperature went below 25° C. But the individual embryonic tissues survive a much lower temperature. Hetherington and Craig (*8*) found that small fragments of chick heart may be stored in Ringer-Tyrode's solution at 0° C for as long as 15 days with little apparent effect on viability. Stone (*14*) concluded that the best temperature for preserving alive the enucleated eyes of the salamander was between 4° C and

6° C. Bucciante (*3*) reported on survival time of various tissues of the 6-to-12-day chick embryo when kept in Ringer's solution at 5° C. He found a wide variation—hepatic cells survived 3 days, while skin survived 21 days. Waterman (*18*) has shown that different tissues of the rabbit embryo and of the chick embryo vary in their sensitivity to refrigeration. He found that 5° C is the most suitable temperature at which to preserve embryonic tissue alive, and that at this temperature brain tissue remains viable for a few days, intestine for many days, and skin up to 3 weeks. He also noted that embryonic tissues survive refrigeration at 0° C for a short time only.

To determine the lowest temperature at which embryonic smooth muscle will survive, the amnion of the chick was used. It is a structure containing smooth muscle but devoid of nervous elements of any description (*7*). When suspended as a muscle strip in oxygenated physiological solution at 41° C, it manifests spontaneous rhythmicity, which may be recorded on a smoked drum (41° C is the approximate temperature of bird's blood). Its motility is increased by acetylcholine, eserine, or barium chloride (*1*). This spontaneous activity or its response to a drug served as a criterion of survival after the structure had been exposed to a low temperature.

Fertile hen's eggs were incubated for 10–17 days. The amnion was removed and placed in a test tube which contained 10–15 cc of either oxygenated Sollmann-Rademaekers' solution (designated S-R solution) or oxygenated cooled expressed almond oil. By placing the tube in a freezing mixture the temperature was lowered to the desired level and held at that point, as closely as was practicable, for 10 min. In some instances, when S-R solution was used, ice formed in the tube. When the structure was thawed out, however, and set up as a strip in S-R solution at 41° C, it exhibited spontaneous activity or reactivity to drugs. Several determinations were made after chilling the S-R solution to various degrees. But when freezing occurred the temperature rose rapidly.

To overcome this difficulty almond oil was used. This oil being moderately unsaturated, iodine number 93–100 (*4*), it remained liquid to about –10° C. Vernon (*17*) found that oil dissolved oxygen more readily than water did. After a muscle had been kept in oil at –2° C for 10 min it would still respond, although it had been frozen. However, the preparations which had been kept in oil at –3° C or lower for 10 min neither developed spontaneous rhythmicity nor reacted to eserine or barium chloride. From experiments in which 12 different preparations were used, it was concluded that smooth muscle of the amnion of the chick irreversibly loses its irritability when kept at a temperature between –2° C and –3° C for 10 min.

Others, experimenting with exsected heart muscle of the frog, found the lethal temperature to be about –3° C (*5*). Ice formation may occur in the muscle; still the muscle survives. It is probable that part of the water in the tissue is in the bound form and as a consequence has properties which differ from those of free water. Newton and Gortner (*10*) found that a portion of the water in expressed plant juice took no part in dissolving cane sugar which was added.

However, freezing of the amnion delayed its recovery in developing a spontaneous rhythmicity. Simonin (*12*) observed the injurious effects of ice formation on subsequent growth of embryonic tissue. The influence of the rate at which tissue is frozen is problematical. It is commonly implied that slow freezing is more injurious to tissue than rapid freezing, as larger ice crystals are associated with the former, and hence more mechanical damage results. However, the results of Breedis and Furth (*2*) indicate that cells survive slow freezing better than rapid freezing. But Thoennes (*16*) found that when small bundles of muscle fibers are immersed in liquid air (–195° C) and rewarmed rapidly they can still respond to electric stimulation.

It is apparent that embryonic tissues survive a much lower temperature than the developing embryo. Cameron (*4*) suggested that the coordinating centers of the central nervous system of the frog fail at a temperature much above that which is injurious to the muscle tissue.

In summary, our results show that: the smooth muscle of the amnion of the chick irreversibly loses its irritability when kept at a temperature between – 2° C and – 3° C for 10 min. Recovery is influenced by the degree of chilling. The greater the chilling, the longer is the time required for recovery. Ice forms in the structure in some instances, yet still it may survive. Part of the water of the tissue may be in the bound form. Isolated nerve-free muscle survives a much lower temperature than the intact embryo has been reported to survive.

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Comments and Communications

Replanting "Discarded" Varieties as a Means of Disease Control

Many soil pathogens accumulate to a high degree in the presence of crops toward which they are virulent. The efficacy of crop rotation as a disease control measure lies in the fact that, in the absence of these crops (i.e., in the presence of nonsusceptible crops), the population of a given pathogen materially decreases. Other pathogens, those to which the alternate crop or crops are susceptible, must as surely increase; but by rotating crops subject to widely different pathogens, effective control is often achieved. Why not then, apply the same general practice in control of such pathogens as the grain rusts, *Helminthosporium* of oats, etc.? Such a practice would involve a rotation of host varieties, rather than of distinct, often widely divergent, crop species.

Development of varieties of crop plants resistant to infectious parasites and insect pests is a significant approach to control of plant diseases. There is now widespread recognition on the part of pathologists, breeders, and practical growers that, contrary to earlier opinion, a new variety represents but a temporary advantage.

''The case of Ceres wheat . . . illustrates this point. This rust-resistant variety was distributed in 1926, and by 1934 was grown on more than four million acres. Race 56 of *P. graminis tritici* was first identified in 1928; in 1930 it comprised only 0.2 percent of the wheat stem-rust population . . . increased to 1.0 percent of the population in 1931, to 2.1 percent in 1932, 3.7 percent in 1933, then increased rapidly to make up 33 percent of the population in 1934 and 66 percent in 1938. Ceres was very susceptible to this race, and in the severe stem-rust epidemics of 1935 and 1937, in which race 56 predominated, Ceres was so heavily damaged that it ceased to be generally cultivated.'' (CHRISTENSEN, C. M. *et al.* *Ann. Rev. Microbiol.*, 1948, 1, 61.)

Again, recent experience with a group of new oat varieties is significant. These varieties, deriving a highly valued resistance to virtually all races of crown rust from the variety Victoria were planted in this country about 1942. Very soon, reports of a new *Helminthosporium* disease appeared. Now widely recognized under the name *H. victoriae*, this pathogen has eliminated all Victoria derivatives from general use.

While focusing our attention on the striking and often disturbingly rapid increase in ''new'' races or species of pathogens in the presence of newly emphasized host varieties, we should not forget that some, at least, of the ''old'' races are correspondingly decreasing. There is likely as significant a decrease in the inoculum of hitherto prevalent pathogens as there is increase in hitherto rare ones! This, coupled with the very possible fact that the old host varieties well may be resistant to the new pathogens, leads to our main thesis: that varietal rotation should be studied as a means of disease control.

The simple fact that a pathogen is new stands as direct evidence that the older varieties were highly resistant to it, and that it was therefore formerly rare. After five or ten years of widespread plantings of a new host type, it may well be that formerly well-known species or races of pathogens will have become scarce, and that older host varieties can be replanted with profit. That many of these discarded varieties are highly desirable is clearly shown by Quisenberry's statement regarding Vicland oats: ''It has been stated that in Wisconsin the years 1942 and 1945 were quite similar so far as climatic conditions for oat production were concerned. In 1942 the average yield in the state was 43.0 bushels per acre when only 90,000 acres of Vicland were grown. By 1945 Vicland had increased to nearly 3 million acres and the state average was 51.0 bushels per acre.'' (QUISENBERRY, K. S. *Chron. Bot.*, 1948, 11, 237.) By selecting for a given crop, such as wheat or oats, several commercially desirable varieties of widely differing susceptibility, it should be possible to work out a type of rotation which would hold disease losses at a low level.

Rotations involving varieties of the same host species will require great care. Yet the principles governing the biological equilibrium between host and pathogen are the same; and such a program seems hardly as difficult as the present constant seach for ever new host varieties. And as McCall points out, ''a change in variety requires no change in farm organization, management, utilization, or general plan of financing.'' (MCCALL, M. A. *Chron. Bot.*, 1948, 11, 273.)

RUSSELL B. STEVENS

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Age of Canada's Principal Gold-producing Belt[1]

The east-west trending belt of infolded rocks that extends across Ontario into Quebec and includes many of Canada's largest gold mines has long been known to be very old in terms of earth history. The belt is a troughlike strip of volcanic and sedimentary rocks of so-called Keewatin and Temiskaming age. It probably represents the roots of an ancient mountain belt that seems, by crosscutting relationships, to be older than all other similar zones in the Canadian shield area (WILSON, J. TUZO. *Trans. Amer. geophys. Union*, 29, 691).

In southeastern Manitoba there is an area in which granitic rocks have invaded similar volcanics and sediments known locally as the Rice Lake series. These granites have been established by both Pb/U and Sr/Rb measurements (HOLMES, ARTHUR. Rep. Comm. Meas. of Geol. Time, National Research Council 1946–47, p. 39; and AHREN‘, L. H. *Nature*, Lond., 1947, 180, 874, to be about 2,000 million years old, the greatest age measured heretofore. This area lies on the line of the above-mentioned east-west belt if extended westward.

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[1] Supported by the Office of Naval Research, in the laboratory established by the Geological Society of America.

Work on the helium method of age determination (Hurley, P. M. and Goodman, C. *Bull. geol. Soc. Amer.*, **54**, 305) has continued since the war, with a further understanding of what conditions are necessary for satisfactory age measurements. Measurements on magnetite in certain "*soft host*" environments seem to be on a fairly firm footing.

Only three samples of magnetite from this eastern mineral belt have been measured so far, but the agreement in age with each other, and with the Manitoba area to the west, offers some assurance that the determinations are reasonably correct. Samples 1 and 2 were specimens of magnetite from the Larder Lake district, Ontario. Sample 3 was magnetite separated from a quartz veinlet in a piece of massive sulphide ore from the Horne Mine, Noranda, Ontario.

Sample	Alphas/hr/cm² from thick source*	Helium 10^{-6} cc/g	Age in millions of years†
1	.36	16.9	2100
2	0.15	8.4	2400
3	.26	11.4	2000

* Nogami, H. H. and Hurley, P. M. *Trans. Am. geophys. Union*, 1948, **29**, 335.

† Assuming 90% of radioactivity due to uranium and 10% to thorium, as is about usual in this type of material.

If these ages are correct, they give us our oldest known orogenic belt.

Patrick M. Hurley

Massachusetts Institute of Technology

Some Simple Calculations Concerning the Efficiency of the Photosynthetic Mechanism

As is well known, the free energy increase resulting from the photosynthetic reaction

$$CO_2 + H_2O = HCHO + O_2$$

is about 120 kcal. Actually, the total amount of energy absorbed is such that the conversion of light into chemical energy is accomplished with an efficiency of 30% or more (Rabinowitch, E. L. *Photosynthesis and related processes.* New York: Interscience, 1945. p. 50.) The reaction above consists of the following oxidation and reduction steps:

$$2H_2O = O_2 + 4H^+ + 4e^-$$

$$CO_2 + 4H^+ + 4e^- = HCHO + H_2O$$

In neutral solution the reversible potential of the first reaction is (Latimer, W. M. *The oxidation states of the elements and their potentials in aqueous solution.* New York: Prentice-Hall, 1938.) + 0.81 v with respect to the standard hydrogen electrode while that of the second is − 0.49 v, the emf of the total reaction being 1.30 v. One will verify that 1.30 × 4 × 23 = 120 kcal.

The formation of oxygen by oxidation of water is, in general, subject to a considerable anodic overvoltage or activation energy. If in particular the formation of molecular oxygen were to require the prior liberation of atomic oxygen from each molecule of water the minimum anodic potential would be the reversible potential for the reaction

$$H_2O = O + 2H^+ + 2e^-$$

which in neutral solution is + 2.00 v.

Similarly the reduction of carbon dioxide to a formaldehyde unit HCHO would be expected to be subject to a considerable cathodic overvoltage. As a matter of fact we have observed (Van Rysselberghe, P. *et al. J. Amer. chem. Soc.*, 1944, **66**, 1801; 1946, **68**, 2047; 2050) that the polarographic reduction of carbon dioxide cannot start until a cathodic potential of about 2 v with respect to the standard hydrogen electrode is reached. The total potential difference would thus be 4 v and the corresponding free energy of the 4-electron oxidation-reduction would be 4 × 4 × 23 = 368 kcal. If the equivalent amount of light energy is absorbed to produce chemical synthesis to the extent of 120 kcal the efficiency of the process is 120/368 = 33%, in good agreement with the value given by Rabinowitch (*op. cit.*).

If we accept a mechanism involving eight quanta (which assumption, supported by other evidence, seems logical in view of the fact that there are altogether eight steps of yielding and accepting of electrons for the overall reaction) the average molar quantum would be 368/8 = 46 kcal, corresponding to an average wavelength of 6210 A. It is interesting to note that the maxima of red absorption in ether solution correspond to 43.3 kcal for chlorophyll a and 44.5 for chlorophyll b (Harris, D. G., and Zscheile, F. P. *Bot. Gaz.*, 1943, **104**, 515). See also our polarographic work on chlorophyll (Van Rysselberghe, P. *et al. J. Amer. chem. Soc.*, 1947, **69**, 809).

The original free energy level of one mole of CO_2 and two moles of H_2O is − 208 kcal. The absorption of 368 kcal brings it up to + 160 kcal. If one subtracts from this the loss of free energy of 110 kcal corresponding to the formation of molecular O_2 from the atoms, one arrives at the value of + 50 kcal for the free energy of formation of the activated complex CH_4O_2 from the elements in their standard states. This value might lead to useful speculations concerning the structure and properties of this complex. Since the final free energy level of one mole of HCHO and one mole of H_2O is − 88 kcal the reaction

$$CH_4O_2 = HCHO + H_2O$$

from the reaction complex to the final products involves a free energy decrease of 50 − (− 88) = 138 kcal.

These considerations are submitted as an extension of the reversible electrochemical point of view already familiar in the field of photosynthesis to the more realistic one of overvoltage and activation. It is hoped that they may be of some use towards the final elucidation of the mechanism of the most important of all chemical reactions occurring in nature.

Pierre Van Rysselberghe

University of Oregon

In Memoriam

Paul Rode

1901–1948

Paul Rode, 47, postwar chief of Biological Museums in the French National Service and inspector general of the French Provincial Biological Museums, died on September 23 in Paris. He was the most productive mammalogist in France and the leading candidate for the professorship of zoology in the Paris Museum from which Edouard Bourdelle retired last year on account of age. The collaboration between Paul Rode and the eminent Paris surgeon, Robert Didier, was fortunate indeed for mammalogy. They were two of the foursome (Bourdelle and Bressou were the others) which inaugurated and carried into its 12th (1948) annual volume the French journal of mammalogy, *Mammalia*. Paul Rode pulled the heaviest load of anyone in that team, as he did in most undertakings in which he participated—never because he was aggressive but because his associates requested him to do so. His loyalty to them and to his science, along with his marvelous efficiency and great industry, were outstanding characteristics. Since he never took his responsibilities lightly, these admirable traits were his undoing, inasmuch as he literally wore out his heart in doing so long the work normal for several men. He is survived by his wife, Renée.

E. RAYMOND HALL

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William John Dann

1904–1948

William John Dann, professor of nutrition in the Duke University School of Medicine, died at his home in Durham, North Carolina on December 15, 1948, after a prolonged illness. Born in Bath, England on November 9, 1904, he received his formal training in the schools of Sheffield University. In 1925 he began graduate training in the Department of Biochemistry at Cambridge University which led to a Ph.D. in 1930. During these formative years, under the influence particularly of F. G. Hopkins, J. B. S. Haldane, and L. J. Harris, his interest in nutrition developed and thereafter his efforts were concentrated in this field. After receiving the doctorate, he remained in the Nutrition Laboratory at Cambridge for four years as Medical Research Scholar of the Worshipful Council of Grocers and as holder of the Beit Memorial Research Fellowship. During these years he published numbers of papers on the estimation of carotene and vitamin A, and on their metabolism.

In 1934 Dr. Dann came to Durham as assistant professor of physiology and nutrition and assumed responsibility for the teaching of nutrition in the Medical School, becoming professor of nutrition in 1946. Here his interest in vitamin A continued, and with his colleagues and graduate students he developed the first successful colorimetric assay for vitamin A and carotene. He continued to study the physiology of vitamin A deficiency in animals as well as man.

Since Durham was in the area within which pellagra was endemic at that time it was inevitable that he should become interested in the nutritional aspects of pellagra. After establishing that what had been described as "rat pellagra" was in truth due to a deficiency of vitamin B_6 and not of the PP factor, he collaborated with the late Y. Subba Row, then at Harvard, in a search for the actual PP principle. This search culminated in the isolation of nicotinic acid, which had not yet been biologically assayed when the announcement of the significance of this compound was made by the Wisconsin workers in 1937. Most of his scientific efforts in the years thereafter were devoted to a study of the physiological sequelae of niacin deficiency. In all, 58 scientific papers remain as his memorial, as well as vol. XII of the *Biological Symposia*, which he edited as his last scientific endeavor. He had also served on the editorial board of the *Journal of Nutrition* and of *Nutrition Reviews*.

Jack Dann carried over the objectivity of his scientific life to his thinking on all other matters. Remarkably free of preformed prejudices of any sort, he was in all matters a true liberal, forming his own opinion after mature, critical consideration of the subject at hand, yet ever willing to reconsider in the light of new facts.

While a student at Cambridge, he married Eileen Morley, who shared with him his chief interests away from the laboratory—namely, people, books, nature, and their four children. His loss is mourned not only by his family, his friends, and Duke University, but by the scientific community at large.

PHILIP HANDLER

Duke University

Book Reviews

Surface active agents: their chemistry and technology. Anthony M. Schwartz and James W. Perry. New York: Interscience, 1949. Pp. xi + 579. (Illustrated.) $10.00.

This is a book that has long been needed. It deals with a modern field of chemistry that has become big business, with applications in many branches of technology. Not only so, but there has developed a whole field of theoretical relations and interesting phenomena that has greatly extended our knowledge of colloids and surface behavior.

The book, after a brief introduction which classifies the materials to be discussed, consists of three parts: Part I devotes 216 pages to processes for synthesizing and manufacturing surface active agents, such as the carboxy acids, the sulfonic esters, the alkane sulfonates, the alkyl aromatic sulfonates, and other hydrophilic compounds, as well as cationic surface active agents of various kinds, and nonionic and ampholytic agents, with brief reference to nonaqueous systems, builders, and mixtures.

This very substantial, comprehensive, and clearly written account consists almost entirely of information published in connection with patents. It is surprising how much of modern organic chemistry has been patented. On every page of this part of the book there are numerous references to relevant patents, amongst which the journal references are completely submerged. The reviewer had not realized what a large proportion of chemical advances have been described in patents rather than in the usual chemical periodicals.

Part II of this very useful book devotes 150 pages to the physical chemistry of surface active agents in theory and practice. It is the most complete discussion of this subject so far available. Not only does it discuss surface and interfacial properties and their relations to chemical constitution, but it gives a careful though somewhat brief review of the properties of solutions of these colloidal electrolytes.

This is followed by a discussion of the "gross effects and technical evaluation of surface active agents," which includes such manifestations as wetting, rewetting, dispersion, foaming, emulsification, and various factors of detergency. Here, as in all parts of the book, the authors have made an attempt to include a complete enumeration of all the significant effects, together with references to the best accounts of specific phenomena.

Lastly, Part III, in another 128 pages, describes the chief practical applications of these important materials throughout the textile industries, in cosmetics and detergents, in pharmaceutical, germicidal, fungicidal, and disinfectant use, in metal technology, in paints and lacquers, inks and pigments, in leather technology, in petroleum and lubricants, in flotation, and in many other branches of industry, such as foods, rubber, and resins. This is a remarkably complete review.

It is evident from the mere enumeration of all these topics, which are presented in well-integrated form, that this book should find a place in every chemistry library. It will be a stimulus to students to look through its pages and see how chemical and physical chemical properties can be applied. It is also an invaluable reference book for those having anything to do with colloidal electrolytes and surface active agents. The authors have rendered a distinct service to chemistry and have added to the value of the mass of information with which they deal by supplying a detailed subject index in addition to a complete author index.

JAMES W. MCBAIN

Stanford University

Temperature and human life. C.-E. A. Winslow and L. P. Herrington. Princeton, N. J.: Princeton Univ. Press, 1949. Pp. xiv + 272. (Illustrated.) $3.50.

This small, well-put-together volume constitutes an excellent handbook for the air conditioning engineer, covering as it does man's *immediate* thermal adjustment to his environment. As a monographic presentation of the authors' fifteen years of work in this field, it is a contribution of value to those engaged in the problems of air conditioning and the physics of body heat loss. By no means, however, does it live up to the broad connotations of its title.

The most important contributions of this Yale group (here presented *in toto*) have been concerned with "partitional calorimetry"—a term they coined to cover their studies on the partitioning of body heat loss between radiational, conductional, and evaporational channels under diverse environmental conditions. They stressed the importance of wall temperature in air conditioning calculations and in other ways provided added refinements for the engineers' activities in this field. However, they consistently refused to accept anything more than a short term relationship between man's thermal environmental and his heat production or general biology. For them, man's slower hormonal response to changes in thermal environment simply does not exist, in spite of adequately documented evidence on the subject.

Your reviewer greatly appreciated being asked to prepare a review of *Temperature and human life*—this field had held his major interest for the past two decades. The book proved rather disappointing, however, in that it has only one chapter dealing—very inadequately—with the more general relationship of climate and the seasons to human biology. The inclusion of only one scientific work published since 1938, among some 39 listed references, clearly dates the authors' thinking in this final chapter. None of the illustrations was prepared later than 1926!

CLARENCE A. MILLS

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NEWS and Notes

J. W. Buchanan has resigned as Morrison Professor and chairman of the Department of Zoology at Northwestern University to become Hancock Professor of Zoology and director of research in the Hancock Foundation of the University of Southern California.

Katherine Way, physicist at the Oak Ridge National Laboratory, has joined the staff of the National Bureau of Standards, where she will conduct research in nuclear physics for the Radioactivity Laboratory. Dr. Way will head a project for compiling a table of present-day nuclear data, to which periodic supplements will be added. The table will be available to scientific institutions, universities, the government, industry, and the public.

V. I. Komarewsky, professor of chemical engineering and director of the Catalysis Laboratory at Illinois Institute of Technology, will speak before the Danish Chemical Society in Copenhagen in September. Dr. Komarewsky, who has been a staff member of the Kaiser Wilhelm Institute of Biochemistry in Berlin and the Moscow Academy of Mines, will discuss the catalytic reaction of hydrocarbons.

Merritt Lyndon Fernald, Fisher Professor of Natural History, emeritus, and former director of the Gray Herbarium of Harvard University, has been elected an honorary member of the Societas pro Fauna et Flora of Finland.

Frederick V. Rand, plant pathologist in the Office of Experiment Stations of the U. S. Department of Agriculture, retired on June 30, after 38 years of government service. Dr. Rand did extensive research in the causes and prevention of bacterial wilt of cucumbers, cantaloupes, squashes, and corn by beetle carriers. He served as executive secretary of the division of Biology and Agriculture of the National Research Council and associate editor of both *Botanical Abstracts* and *Biological Abstracts*.

E. W. Comings, professor of chemical engineering at the University of Illinois, will spend a month at the Army Chemical Center this summer. During this time he will make a study of special problems of the Technical Command and the Medical Division. In addition, he will give a series of lectures on fluid dynamics to a selected group of chemical and mechanical engineers of the Army Chemical Center.

Visitors to U. S.

Recent visitors at the National Bureau of Standards were **S. C. Stokes**, British Rubber Producers' Research Association, Welwyn Garden City, Hertfordshire, England; **G. C. Ellis**, metallurgist with the Armament Research Establishment, London; **Geoffrey G. Haselden**, lecturer in low temperature technology, Imperial College, London; **O. H. Saunders**, professor of engineering at London University; **G. P. Douglas** and **E. G. Broadbent**, both of the Royal Aircraft Establishment, Farnborough, England; **Karl G. Ekblad**, civil engineer at Chalmers University, Gothenburg, Sweden, who is here on a year's Scandinavian-American fellowship; **R. H. Field**, chief of the Metrology Section of the Canadian National Research Council; **Roger Coutant**, director general of the Ateliers Pingris et Mollet Fontaine Reimis, Lille, France; **J. Kampe de Fériet** of the University of Lille, France; **L. P. Buseth**, chemical engineer with the A. S. De Forenede Ullvarefabrikker of Oslo, Norway; **Giuseppe Francini**, professor of electrical engineering, University of Bologna; **A. R. Burgess**, of the Imperial Chemical Industries, Ltd., England. Visitors from India were **S. Sankaralingam**, assistant engineer with the government of Madras and at present associated with the University of Louisville; **R. R. Umarji**, professor of mathematics at Gujarat College, Ahmedabad, and member of the Bombay Education Service; and **K. Rajagopalaswami**, chief geologist of the Associated Cement Companies, Ltd., Bombay.

Luis Richard, tuberculosis specialist at the Hospital del Salvador, Santiago, Chile, is working with the Massachusetts State Department of Health in Boston.

H. O. Hartley, Department of Applied Statistics of the University of London, is here for six months to edit "An Index of Tables for Statisticians" on behalf of the Subcommittee on Statistical Tables, National Research Council.

Luis J. Giove Deacon, associate professor of human anatomy at the Medical School of the University of San Marcos, Lima, Peru, is here as consultant on plans for a maternity clinic to be operated by the Maternity Home in Lima, of which he is the director.

Vincent Russo, Buenos Aires economist, is visiting in Washington and New York until August 5, when he will leave for an assignment in Rome, Italy.

Grants and Awards

The National Cancer Institute has made one new grant and 39 renewals totaling $872,477 to medical schools and one new grant and 15 renewals totaling $81,439 to dental schools for continued cancer training programs. The two schools receiving aid for the first time are the Chicago Medical School and the University of Nebraska College of Dentistry. Thirty-six special cancer control grants totaling $550,802 were made to state and local health agencies, universities, hospitals, and other nonprofit organizations.

Henry P. Hansen of Oregon State College was the recent recipient of the 1948 **George Mercer Award** for for the outstanding paper in the field of ecology published in the United States and Canada in 1947. Dr. Hansen's paper, "Postglacial Forest Succession, Climate, and Chronology in the Pacific Northwest," appeared in the *Transactions* *of the American Philosophical Society.* Presentation of the Mercer Award, which honors Lieutenant George Mercer, a young British ecologist killed in World War I, was made at the summer meeting of the Western Section of the Ecological Society of America held in Vancouver, B. C., June 14–18.

Meetings and Elections

The Biological Photographic Association, Inc. will hold its 19th annual meeting in Cleveland, Ohio on September 7–10 at the Hotel Cleveland. A program covering all phases of biological photography is being assembled. Inquiries regarding commercial exhibits should be addressed to Fred S. Beal, St. Luke's hospital, 11311 Shaker Boulevard, Cleveland 4. The pre-convention issue of the *B. P. A. Journal* will give complete details of the convention plans.

The Ohio Academy of Science elected as officers for the year 1949–50 at its 58th annual meeting: Paul B. Sears, Oberlin College, president; Rush Elliott, Ohio University, secretary; R. M. Geist, Capital University, treasurer.

At the recent business meeting of the **Paleontological Society of Washington,** held at the U. S. National Museum, the following officers were elected to serve for the year 1949–50: president, James Steele Williams, U. S. Geological Survey; vice president, Helen M. Duncan, U. S. Geological Survey; secretary, David Nicol, U. S. National Museum; treasurer, A. L. Bowsher, U. S. National Museum; and member of Executive Committee, A. R. Loeblich, Jr.

The Illinois State Academy of Science elected the following officers for 1949–50 at its 42nd annual meeting: Thorne Deuel, director of the Illinois State Museum, Springfield, president; Percival Robertson, Principia College, Elsah, first vice president; F. M. Fryxell, Augustana College, Rock Island, second vice president; Leland Shanor, University of Illinois, Urbana, secretary; W. W. Grimm, Bradley University, Peoria, treasurer; and Dorothy E. Rose, Illinois State Geological Survey, Urbana, editor. Leland Shanor is representative to the AAAS.

The Illuminating Engineering Society elected the following new officers as of October 1: Charles H. Goddard, of the Sylvania Electric Products Inc., Ipswich, Massachusetts; S. G. Hibben, Westinghouse Electric Corporation, vice president; E. M. Strong, Cornell University, treasurer; A. H. Manwaring, Philadelphia Electrical & Manufacturing Company, general secretary.

A Wood Symposium, cosponsored by the National Research Council and the Office of Naval Research, was held on June 16–17, at the National Academy of Sciences in Washington, D. C. The conference was called to acquaint scientists and men in the lumber industry with the military requirements of wood and wood products and also to discuss present-day investigations and improvements in the field.

Karl T. Compton, chairman of the Research and Development Board, National Military Establishment, stated in the opening address that "from the standpoint of research and development of the National Military Establishment there is, of course, a responsibility and interest in seeing that anything that can be done to improve materials or equipment for military purposes is done, within the limits of man power and funds available for the work."

The keynote of the conference was conservation. Methods of controlling marine borers are being studied in several laboratories. Physiological studies of wood-rotting fungi, with a view to understanding the basic functioning of the organism in order to find a point at which it might be attacked, are under way at the Department of Plant Sciences at Syracuse University, supported by the Office of Naval Research. Two other ONR-sponsored projects, one at Fordham University and one at the University of Maryland, are exploring the chemistry of lignin. An investigation of the effects of insects on wood is a combined project of the Corps of Engineers and the Department of Agriculture. The chemical utilization of wood and wood residues is being studied at the U. S. Forest Service's Forest Products Laboratory. The Yale University School of Forestry is surveying wood supply and analyzing tropical woods.

Papers presented by Army and Navy participants revealed the enormous amount of lumber required for shore installations as well as for the thousands of small craft needed in landing operations, rescue work, and coastwise transportation. A review of World War II requirements showed that in 1944 close to three million tons were needed for all installations, afloat and ashore; and for wood-packaging alone it was estimated that half the total harvest was going into containers as of August 1945. While peacetime requirements are much smaller, the services realise that in another conflict they would operate in an economy of scarcity rather than one of plenty such as existed at the beginning of World War II. It may seem strange to the layman that, aside from small boats, wood is used to the extent it is in combat ships, but no adequate substitute for wood has yet been found for weather decks and for flight decks. It is required over the steel plates to keep the temperatures in living spaces more equable, to afford better footing in rough weather, and to facilitate topside access for damage control crews during intense fires when steel may reach extremely high temperatures. Teakwood is considered the ace of all decking woods, and for carriers of the Iowa class a total of 110,000 board feet are needed.

Particular attention was given to the marine borers; the several species of these which attack wood bottoms, piles, and other submerged wooden structures cause an estimated 100 million dollars damage a year in the United States and its possessions. A survey of the distribution of borers in the Pacific islands and on the Atlantic coast was described at the meeting and advances in protective measures were discussed. The Industrial Test Laboratory at the Philadelphia Naval Shipyard reported that the addition of silica to the glue used in plywood offered excellent protection when plywood was used as sheathing on wooden vessels. While many of the projects were of an empirical nature, the need for more fundamental research, especially in the life history of the borers, was stressed. A project of this type has been undertaken by the University of Miami in an attempt to determine the exact stage of wood penetration and also the physiological nature of the action of creosote and other preservatives on the borers.

Although no new preservatives were reported, search and experimentation continues and methods of application and the life span of accepted preservatives are under constant study. The rapidly diminishing supply of lumber in this country would place this commodity in a critical position in the event of another war, and methods of expanding the use of what is available and extending its life after it is fabricated deserve continued research.

NRC News

The Pacific Science Board has made the assignments and field arrangements for the Scientific Investigations in Micronesia Program, an extension of the 1947–49 Coordinated Investigation of Micronesian Anthropology. This new program is financed by the Office of Naval Research in cooperation with the Pacific Science Board and institutions with which the participants are associated.

Nine scientists have been selected and a number have already left for the field. *I. Dyen*, associate professor of Malayan Languages of Yale University, will continue the linguistic work that he started under the CIMA Program on the island of Yap. Dr. Dyen will also spend a short time in Ponape, where he will assist in clarifying certain problems involved in the new orthography evolved from Paul L. Garvin's linguistic work there under the CIMA Program. It is expected that this new orthography will be adopted for general use. *Ann Meredith*, of Radcliffe College, who has been studying social anthropology at Harvard University, expects to study the relationship between the sociocultural system and the socialization process among the native peoples in the Truk area. *Sidney Glassman*, of the University of Oklahoma, will conduct a botanical survey of the island of Ponape with a view to preparing a flora of Ponape. *Irwin Lane*, of the University of Hawaii, will make a botanical survey in the Palaus during a four-month period in which he will study in particular the orchids of that area. He expects to base his operations at the Pacific War Memorial Field Station in Koror, which is being operated by Peter J. R. Hill, the resident naturalist for the station. *F. R. Fosberg*, research associate in the Department of Biology of Catholic University, will make a four-to-five-month study of plant ecology in the Marianas, with special emphasis on environmental factors affecting the distribution of island species. Dr. Fosberg will be engaged in research for the Quartermaster Corps of the Department of the Army. *Donald Anderson*, of Honolulu, Hawaii, will accompany Dr. Fosberg as a botanical assistant. *M. W. de Laubenfels*, professor of zoology of the University of Hawaii, will conduct a sponge survey, during a period of four months, of certain island areas of the Marshalls, and particularly of Ailinglapalap, as well as of the Truk and Palau areas of the Caroline Islands. *Eugenie Clark*, of the American Museum of Natural History, will conduct a four-month research project on the taxonomy of plectognath fishes in the Palaus. She will base her operations at the Field Station of the Pacific War Memorial in Koror. *Robert K. Enders*, professor of zoology at Swarthmore College, will spend a period of four months on the island of Saipan and other islands of the Trust Territory, during which he will carry out ecological studies with special reference to introduced races of rats. Dr. Enders will also conduct a general ecological survey to determine the best locality for future biological research on specific problems.

In addition to this special program, the Pacific Science Board has sent two scientific investigators, supported financially by the Office of Naval Research, into the Trust Territory to conduct further research on a giant African snail, *Achatina fulica*. *Albert R. Mead*, assistant professor of zoology at the University of Arizona, and *Yoshio Kondo*, of the Bernice P. Bishop Museum, will devote close to four months in the Marianas and Palaus to the study of factors which might be helpful in the control of the giant african snail, and will make a survey collection of land shells on selected small islands.

The Food and Nutrition Board of the National Research Council met May 6–7, and heard reports from chairmen of its fifteen committees. The board reaffirmed its position favoring extension of the compulsory enrichment of corn products in those states where corn is a substantial dietary constituent. The board also went on record in favor of rice enrichment, but since rice is not a significant dietary constituent in the U. S. except among isolated population groups, compulsory enrichment was not advocated.

At the request of the U. S. Public Health Service, the board stated its position with regard to the addition of vitamins A and D to skim milk and the use of ascorbic acid in milk for prevention of oxidative off-flavor. The board has continued to adhere to its policy of recommending additions of vitamins to foods only when there is a distinct public health benefit to be attained. The board has no objection to additions of vitamins to milk in reasonable amounts for special purposes, provided the practice encourages consumption of milk and does not increase the cost or reduce the availability of milk or its products to those who need it most.

The board acted to place on a standing basis its *ad hoc* Committee on Food Protection, which has been reviewing the public health implications of pesticide residues and chemicals being added to foods for special purposes. H. E. Longenecker, dean of the Graduate School, University of Pittsburgh, is chairman of this committee.

New members of the board, nominated for appointment by the NRC under a rotational plan are: W. J. Darby, Vanderbilt University; N. B. Guerrant, Pennsylvania State College; D. B. Hand, New York Agricultural Experiment Station; Ancel Keys, University of Minnesota; O. H. Lowry, Washington University; and R. J. Williams, University of Texas Medical School. These men replaced C. A. Elvehjem, W. E. Krauss, L. A. Maynard, W. H. Sebrell, H. C. Sherman, F. F. Tisdall, and R. R. Williams. Frank G. Boudreau, executive director of the Milbank Memorial Fund, was reappointed chairman of the board for the coming year.

The NRC Committee on Public Health Aspects of Brucellosis met in Washington, May 9–10, with Wesley W. Spink from the University of Minnesota presiding.

The objectives of this committee are: to prepare definitive statements on the problem of brucellosis in animals and its control; to define diagnostic criteria for human brucellosis and to make recommendations for its prevention and treatment; and to encourage research on brucellosis.

A report prepared for the committee by L. M. Hutchings, C. K. Mingle, and W. L. Boyd, "Eradication and Control of Brucellosis in Animals," was revised and approved for publication by the committee. It is hoped that this report will aid the efforts of those groups attempting to resolve the problem of brucellosis in domestic animals.

One of the major problems pertaining to human brucellosis is the standardization of diagnostic procedures among various laboratories. A questionnaire, responded to by 45 states, the District of Columbia, and three Canadian provinces, revealed a marked lack of uniformity in carrying out tests. In view of the situation, the committee is preparing a statement on recommended laboratory procedures for the diagnosis of human brucellosis. In this connection, six to ten state laboratories were to be requested to cooperate in carrying out standardized agglutination tests.

The committee is cooperating in the plans for a symposium on brucellosis, to be held in Washington this fall, and also for an Inter-American Congress on Brucellosis, to be held in Washington in the fall of 1950.

Deaths

Ray Lyman Wilbur, 74, president of Stanford University for 27 years and its chancellor since 1943, died June 26. Dr. Wilbur was U. S. Secretary of the Interior under President Hoover and served as president both of the American Academy of Medicine and the American Medical Association.

Birbal Sahni, 58, professor of botany and dean of the Faculty of Science at Lucknow University, India, died April 9. A fellow of the Royal Society, Dr. Sahni had recently been elected to preside over the International Botanical Congress next year.

Irving S. Lowen, 38, associate professor of physics at the Washington Square College of New York University, died on April 23. Dr. Lowen was research associate with the Manhattan Project and an associate of the National Defense Research Committee during the war, and later a consultant of Brookhaven National Laboratory and director of the U. S. Navy project on cosmic rays.

Preston Strong Millar, 69, president of Electrical Testing Laboratories, Inc., died June 17 at his summer home at Glen Spey, New York. Mr. Millar was one of the founders of the Illuminating Engineering Society, its president in 1913, and the recipient of its gold medal in 1945.

The ionosphere is being explored by lightweight rockets, which carry a hundred pounds of recording instruments into the upper atmosphere. In Navy tests at the White Sands Proving Ground in New Mexico the Aerobee rockets reached a velocity of 4,100 feet per second in about 45 seconds, and attained an altitude of over 70 miles. The Aerobee is about 20 feet long and 15 inches in diameter, and weighs 1,665 pounds. It was designed and constructed for the Navy Bureau of Ordnance by the Aerojet Engineering Corporation of Azusa, California, under the technical guidance of the Applied Physics Laboratory of Johns Hopkins University.

Data which the instruments gather in flight are obtained by means of radio transmission from a telemetering set, and by recovery of photographic film from the wreckage. Impact shock in landing has been reduced by explosive separation of the tailfin structure from the rocket during descent and the film, which is contained in heavy metal casing, is recovered intact.

Through study of the ionosphere, scientists hope to answer questions regarding the composition of the atmosphere at high altitudes, cosmic rays, and the sun's spectrum.

The ancient city of Madaba, which served as a diocesan center for Christians from about 300 to 600 A. D., will be the subject of an archaeological survey this summer. A. Henry Detweiler, professor of architecture at Cornell University, left June 26 to make a topographical study of the city, which has not been thoroughly explored since 1901. The site previously yielded the Madaba Map of Palestine—a mosaic on a church floor which showed how the country looked during the Byzantine period. Professor Detweiler, in addition to surveying Madaba, will serve as director of the American School of Oriental Research in Jerusalem during the summer.

The professional library of the late **Burton E. Livingston** has been given to the Hebrew University, Jerusalem. Dr. Livingston was professor of plant physiology and forest ecology and director of the Laboratory of Plant Physiology at Johns Hopkins University, Baltimore.

The Composition and Mechanism of Formation of Gastric Acid Secretion

Franklin Hollander

The Gastroenterology Research Laboratory
The Mount Sinai Hospital, New York City

ONE OF THE MOST IMPORTANT PROBLEMS *confronting* the clinical physiologist today is how the stomach makes its hydrochloric acid. Nowhere else in the body does a physiological fluid regularly attain a pH less than 3.0, let alone a value between 0.8 and 0.9 of a pH unit. Formation of such a solution requires the liberation of a strong acid, at concentration of about 0.17 N. This process has always fascinated me because of the simplicity of the chemical entity involved, but my interest in the problem derives from utilitarian clinical considerations as well.

Some fifteen years ago, Dr. Alvarez of the Mayo Clinic said that the unequivocal cure of gastrointestinal ulceration awaits a medical procedure based on the complete elimination of acid formation in the stomach, and in order to attain this it is necessary that we learn how to "throw a monkey wrench" into the machinery of the acid-forming cells. This in turn requires an understanding of the cellular mechanism itself, and it is this fundamental cytological process that I am about to discuss—not because I am prepared to offer a monkey wrench for clinical purposes, but because I think we have already gained considerable insight into the machinery we aim to disrupt.

The first suggestion regarding the chemical reaction by which acid is formed in the gastric mucosa was offered by Maly (*24*) in 1877—more than fifty years after Prout (*26*) reported his proof that this acid is HCl. Maly believed that a double decomposition takes place between NaCl and primary sodium phosphate, but he did not state how the two products of the reaction were separated and a reversal of this double decomposition prevented. To compensate for this deficiency, Bergeim (*1*) in 1914 suggested that the NaCl be viewed as reacting with the corresponding calcium acid phosphate, since the resulting secondary phosphate of calcium will precipitate out of solution. Even this mechanism will not bear too close a scrutiny, however. Then, twenty-five years after Maly, Bunge (*3*) suggested that carbonic acid, rather than the H_2PO_4 radical, might be the source of the acidic hydrogen. This possibility remained dormant until 1939, when Davenport (*5*) discovered that the carbonic anhydrase activity of gastric mucosa is enormous—as in the erythrocyte. As a result of this observation, he and Fisher (*7*) revived the Bunge theory and proposed that the entire reaction might be speeded up under the influence of this enzyme—an idea which received considerable support from other investigators. However, quantitative evidence concerning the relative inhibitory actions of thiocyanate ion, sulfanilamide, and thiophene-2-sulfonamide on carbonic anhydrase activity and on the production of gastric HCl *in vivo* proved to be inconsistent with the theory, and in 1946 Davenport was led to retract his hypothesis (*6*)[1]. Instead of H_2CO_3, a number of insoluble weak organic acids have been proposed from time to time as the interactant which liberates HCl from NaCl. These include edestin or some other protein—as suggested by Robertson (*28*) in 1924 on the basis of some very early work of Osborne's; a "lecithalbumin" found in hog mucosa by Rassers (*27*) in 1928; and certain undefined substances which give rise to a phase boundary phenomenon propounded by Clowes (*4*) in 1916, and by Beutner and Caplan (*2*) in 1932.

Many writers have supported a physicochemical reaction based on the Donnan equilibrium, but—as I pointed out some years ago (*19*)—this hypothesis demands an impossibly high chloride ion concentration of 7 million molar in the parietal cytoplasm. There is also a process described by A. P. Mathews (*25*) in 1925, whereby intracellular deamination results in the secretion of NH_4Cl by the parietal cell; the salt then undergoes hydrolysis in the neck of the gland, with reabsorption of NH_4OH as ammonia and consequent liberation of HCl into the lumen of the stomach. Our interest in this hypothesis has recently been revived by the excellent work of D. Glick (*8*), wherein he has demonstrated a correlation between the urease activity of minute specimens of the mucosa from successive levels of the gastric gland and the density of parietal cells at these different levels. Since urease is effective in producing ammonia from urea, Glick is now justified in pursuing the hypothesis that this enzyme is an integral part of the intracellular acid-producing mechanism by a process of the kind suggested by Mathews. As another variant of this theory, Hanke (*10*) suggested the cellular extrusion of an organic chloride with a chloroesterase which hydrolyzes the chloride to HCl and a reabsorbable alcohol. Hanke was never able to find such an enzyme in the gastric mucosa and ultimately retracted this hypothesis (*11*).

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[1] In spite of this retraction, the essence of the carbonic anhydrase theory has been retained by several subsequent investigators, e.g.: Davies, R. E. and Edelman, J. *Biochem. J.*, 1948, 43, lvii. Patterson, W. B. and Stetten, DeW., Jr. *Science*, 1949, 109, 256.

And finally there is a physicochemical mechanism based on a membrane hydrolysis of NaCl which I proposed some years ago (*12, 19*), and by means of which I attempted to cope with certain aspects of the problem neglected by these other investigators. Before I describe this system, however, I want to tell you some of the accumulated experimental evidence on which this hypothesis now rests.

As one reexamines the various hypotheses concerning acid production by the parietal cell, it becomes evident that they all suffer from two major deficiencies: (1) no physicochemical mechanism is offered to explain how the HCl can be removed from the interior of the cell, which contains buffered cytoplasm at a pH, presumably, in the neighborhood of 7.4; and (2) the presence or absence of other chemical constituents of the parietal secretion is completely neglected. These two considerations are closely interdependent, and in order to include them in any explanation of parietal cell activity it is essential that we know the chemical composition of the pure parietal secretion as it emerges from the cell. To determine this directly in the mammal, by a micropipetting technique like that employed in studying the kidney tubule, is impossible because the inner diameter of the gastric tubule is usually less than 10 microns. Orogastric intubation of unoperated men or dogs is obviously of no avail, because the gastric juice so collected is always contaminated with saliva and the mixed buffer-containing secretions which are regularly regurgitated from the duodenum. Even the gastric juice derived from a Pavlov or other type of gastric pouch, though uncontaminated by these extragastric secretions, is a mixture of several different secretions from the diverse glandular elements of the stomach mucosa itself. In addition to the acid parietal secretion, this mixture comprises: the alkaline mucus from the columnar cells on or near the surface of the mucosa; another alkaline fluid, designated mucoid or dilution secretion, which may originate in the neck chief cells; and finally pepsin secretion from the zymogen or body chief cells. Thus, it is patently impossible to collect pure parietal secretion even from an isolated stomach pouch, not to speak of the intact viscus itself.

And so it became necessary for us to attack the problem indirectly, by studying how the quantitative composition of gastric juice varies with changes in certain pertinent physiological conditions. To describe our experimental procedures very briefly, we prepare our Pavlov pouches in the usual manner from the gastric corpus, as depicted by the original Pavlov diagrams. The Heidenhain pouch is similar to this, except that it is entirely separated from the main stomach and therefore completely deprived of its vagal innervation, whereas the Pavlov pouch continues to receive some of its original vagal innervation through the isthmus.

In the course of our own work (*22*), we discovered that Pavlov and his students had an entirely erroneous idea of the distribution of the gastric vagi in the dog. They believed that only the anterior gastric vagus runs along the lesser curvature, as in man, but that the posterior trunk courses along the greater curvature. Actually, dog and man are alike in that the two trunks run parallel along the lesser curvature. Consequently, in preparing the usual Pavlov pouch, most of the branches of these nerves are cut across and only a small fraction of the preoperative innervation to the mucosa of the pouch area is retained—instead of the full supply as had been generally believed for many years before. As a result, we devised a different type of accessory stomach which avoids transection of the vagal branches in the seromuscular layer and therefore retains practically all of its original supply of parasympathetic innervation (*21*).

Whatever the type of operation, however, the mouth of the pouch is delivered and fixed through a stab wound to the left of the midline, and the skin surrounding the stoma frequently remains uneroded for long periods, provided the dog is dressed meticulously two or three times a day and is generally well cared for otherwise. In the experiment, the animal is supported in a saddle, and a special collecting device is attached to the abdomen with the rubber catheter inserted into the mouth of the pouch. For certain purposes which I shall describe later, the presence of this catheter inside the pouch in undesirable, and so we perform the operation in such a way that the stoma can be kept closed by sphincteric action of the abdominal muscle fibers (*20*). Gastric juice secreted in such a pouch is usually retained for considerable periods of time, even when the animal is left with the dressing on. To draw off the retained fluid, a narrow catheter is inserted, but left there only long enough to aspirate the contents with the aid of a syringe. Using this retention or discontinuous collection technique, the catheter is in contact with the mucosa for only a fraction of a minute, whereas by the older, continuous drainage method, it is held in position throughout the experiment, which usually lasts for several hours.

Now, what is the chemical composition of gastric juice from such accessory stomach pouches? Of course it contains free and combined hydrochloric acid, pepsin, two different mucins, and even small amounts of other organic compounds. Besides these, however, there are significant amounts of other ionic substances—notably sodium, potassium, calcium, bicarbonate, and phosphate. The quantitative composition of pure pouch juice varies extensively, and this variation is particularly marked as regards the acid component. Thus our first efforts aimed to find out whether there was any regularity about these variations, and we started with the fundamental relation between acidity and rate of secretion. Using the continuous collection technique, with the dog in the stand and food as a stimulus, we confirmed the observation of previous investigators that the curves for these two variables, plotted against time of collection after feeding, are roughly parallel (*20*). This was observed with meat alone and with a synthetic nutritionally balanced diet devised years ago by Karr and Cowgill for dog nutrition experiments. This same parallelism was encountered in fasting dogs when histamine was used as the stimulus (Fig. 1—Exp. B 20), provided the dosage was such as to induce a secretory rate of about the same magnitude as in the feeding experiments. More recently we have found this to be true also for other stimuli like meat extract, pilocarpine, mecholyl, and insulin hypoglycemia.

Both Pavlov and Rosemann knew of this correlation between acidity and rate of secretion, but their interpretations of it were radically different (*14*). Rosemann believed that the relation is inherent in the activity of the parietal cell itself, whereas Pavlov believed that the parietal fluid is ejected by the cell at a constant concentration of acid, independent of the rate of secretion, and that all the variations in acidity below this maximum result from neutralization by mucus. Under well-controlled conditions, a healthy nonirritated pouch may be expected to secrete mucus at a fairly steady rate. Hence, when the rate of parietal secretion is high the proportion of admixed mucus will be low and so will the extent of neutralization. When, on the contrary, the rate of acid secretion is relatively low, the proportion of mucus in the mixed juice will be greater and the acidity correspondingly lower. Neither of these investigators had ever been able to confirm Rosemann's theory, nor had any of their subsequent supporters, and so we attempted to obtain crucial evidence on the subject.

To this end we sought changes in the character of the acidity-time curves which might be associated with a marked change in rate of secretion, such as is obtained with maximal dosages of histamine. The results of these studies confirmed Pavlov most beautifully; when the dosage was increased eightfold, the maximum rate of secretion was more than doubled, but the parallelism between rate and acidity disappeared. Instead, the acidity curves rose promptly to plateau values (Fig. 1—Exp. B 27) around pH 0.91 and remained there throughout the experiment, until the rate of flow had again dropped to the postprandial level or lower.

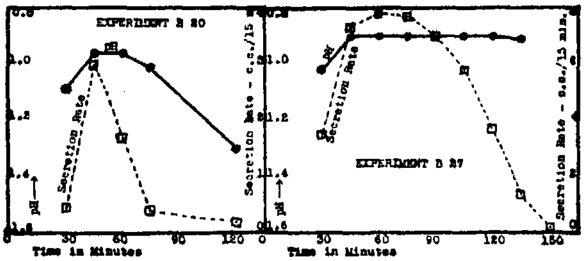

FIG. 1. Continuous collection experiments with histamine as stimulus. Experiment B 20 was performed on a dog with a low secretory rate stimulated by 0.05 mg of histamine per kg; experiment B 27, on a dog with a high secretory rate stimulated by 0.4 mg of histamine per kg.

Furthermore, it happens that one of our Pavlov pouch dogs developed a real hypersecretion immediately following parturition—and this did not diminish significantly until her puppies were weaned (*13*). The hypersecretion was probably continuous throughout the 24-hour cycle, and the daily output during the period of lactation was more than ten times that observed during the control periods. A similar though less marked effect was subsequently obtained with another one of our pouch dogs. In spite of this huge increase in secretory activity, however, the total acidity for 66 samples of this hypersecretory pouch juice from the first animal averaged 157 ± 7 mM—corresponding to a pH of 0.89 ± 0.01. The agreement between these data and those from the histamine experiments is striking.

Another confirmation for the Pavlov theory of constant acidity could be obtained if we were able to reduce the flow of mucus secretion markedly in postprandial and similar experiments where the rate of acid secretion is low. Starting with this idea, we reasoned that the mucus may be evoked by mechanical stimulation of the surface epithelium with the collecting catheter, and that additional neutralizing action may sometimes come from a transudate or exudate associated with mild degrees of inflammation or trauma. In order to minimize these two effects, we devised the sphincter-pouch technique that I mentioned previously, for collecting juice without the aid of the collector. Then, when the postprandial and low histamine experiments were repeated by this new technique, and special attention was given to avoid trauma to the mucosal lining of the pouch, and the pouch was freed of retained mucus by washing out with the first portion of juice secreted in each experiment, we obtained results wholly in accord with our expectation. The acidity rose promptly to values well above those obtained in the corresponding continuous collection experiments, and usually it was in the range of the plateau values obtained with high histamine dosage and spontaneous hypersecretion, i.e., pH 0.91 ± 0.02.

This limiting value seemed to be characteristic of the pure parietal secretion, but actually specimens having pH's of this magnitude still contain small, but significant amounts of the alkaline component of the gastric juice. To demonstrate this, let us see how some of the other chemical components of this pure gastric secretion are related quantitatively to the acidity. In any one experiment, the time curves for total chloride concentration and titrimetric acidity are parallel, in much the same way that the acidity and volume-rate curves are parallel (*15*). Such variations in total chloride also were in accord with Pavlov's theory, but they directly contradicted the reports of Rosemann and others that the total chloride concentration is constant, regardless of the acidity.

The positive correlation between total chloride and total acidity is even more clearly evident from a statistical analysis of the data obtained in a group of 19 experiments. Plotting these variables directly against each other, we obtained a good straight line (Fig. 2) in the acidity range above 100 mM, irrespective of whether the specimens of pouch juice were collected continuously with the dog in the collecting stand, or intermittently by the sphincter retention technique.

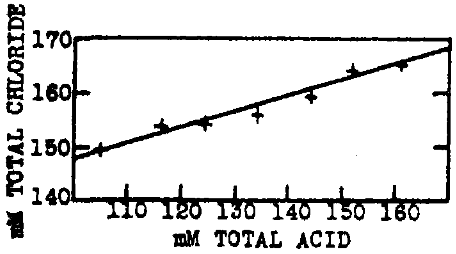

FIG. 2. Total chloride as a function of acidity; mean curve for 121 specimens obtained in 19 continuous collection experiments.

We next calculated the neutral chloride—that is, the combined alkali and alkaline earth chlorides—as the difference between acid and total chloride concentrations, and plotted these values against the total acidity. Again we obtained a straight line (Fig. 3)—of mathematical necessity because of the previous total chloride-acidity relations—but this time the correlation was negative, i.e., the higher the acidity the lower the neutral chloride value. In this particular set of data for 31 specimens of gastric secretion obtained in a series of retention experiments with a single dog, the correlation coefficient is −0.98. This exceedingly high value probably reflects the selected character of the specimens, which results from the refinement of experimental technique. The correlation coefficient for the other set of 121 specimens obtained in 19 continuous drainage experiments is somewhat lower, −0.84, but still high enough to demonstrate the validity of this rectilinear relation between neutral chloride and total acidity. Of six such sets of data subjected to correlation analysis, four gave coefficients between 0.97 and 0.99 (*18*). The lowest neutral chloride value actually obtained in these experiments was 3 mM, with a corresponding acidity of 162 mM. The specimen of secretion giving these values was one of the purest we ever encountered, and did not contain a single flake of insoluble mucin.

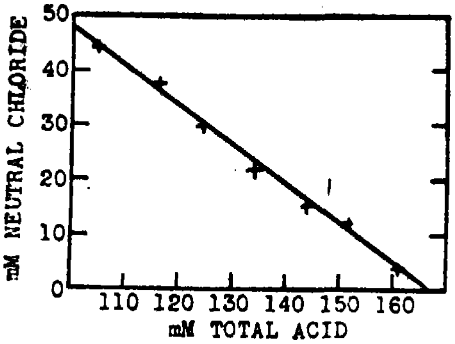

FIG. 3. Neutral chloride as a function of acidity; mean curve for 121 specimens obtained in 19 continuous collection experiments.

Now, let us consider the acidity intercept of the graphs for these two variables. This statistic is defined by the point where an extension of the straight line graph crosses the horizontal or acidity axis, and it corresponds to the acidity of a hypothetical specimen of gastric juice which has a neutral chloride concentration of zero. From the data for this particular experiment, the intercept is 167 mM; for all 6 sets of data which we studied statistically, the intercept varied in the range 157–169, with a weighted mean of 165 mM. Similar graphs, of varying statistical reliability, have been obtained for total nitrogen, total solids, ash, and organic solids, but I shall not take time to present the evidence in detail. Suffice it to say that if we accept the validity of this extrapolation technique, the hypothetical pure gastric juice of zero neutral chloride content has the following composition: a total acidity in the neighborhood of 165 to 170 mM; practically the same concentration of free hydrochloric acid, and therefore a combined acidity of zero; a total chloride concentration identical with the total acidity, in conformity with the absence of neutral chloride. Everything else is virtually absent—inorganic phosphate, organic phosphorus, both inorganic ash and organic solids, and those several components indicated by the Biuret, Hopkins-Cole, and Molisch tests. The specific gravity is estimated to be 1.001, and the freezing point depression slightly over 0.6° C, very slightly hypertonic (*16*).

I recognize that mathematical extrapolation of physiological data is in general a highly precarious procedure, but since in most of the present instances the experimental data approach close to the intercept values, the range of extrapolation is very short and I believe that we may accept this mathematical technique with considerable confidence. An effort to refute our results has been made by Liu, Yuan, and Lim, by treating the data mathematically in a different way (*23*). However, some of their inferences have already been disproved by Gray and by ourselves, and the remainder still await confirmation. Also, Gray (*9*) has reported evidence to indicate that the parietal secretion is free of sodium but contains potassium at a constant concentration averaging slightly above 7 mM. This is in conflict with our finding of neutral chloride concentrations as low as 3–5 mM in several specimens which we analyzed, and the discrepancy still awaits clarification.

All of the foregoing evidence, therefore, leads to the conclusion that the fluid normally secreted by the parietal cells is a very slightly hypertonic solution of virtually pure HCl, having a titrimetric acidity around 0.17 N and a pH around 0.87. It contains extremely little if any ash or organic solids of any kind, and its composition is practically independent of its rate of formation, the intensity of the stimulus, and probably even the character of the stimulating agent. The combined acidity, neutral chloride, inorganic phosphate, and various organic substances invariably encountered in mixed gastric juice all derive from nonacid buffer-containing secretions: pepsin, mucus, the hypothetical mucoid or dilution secretion, and even small amounts of transudate which enters the pouch from the interstitial spaces. It is this mixture of nonacid buffer-containing fluids that I have designated the "nonacid component" of the gastric juice (*17*).

Now let us return to our main problem of how the acid secretion is made, and particularly how it is separated from the other solutes in the cytoplasm. If the secretion contains only HCl, and that at a nearly isotonic concentration, there is only one answer to this question that I can see (*19*). I believe we must accept the parietal cell as the source of this secretion, if only because of the evidence of Linderstrom-Lang and his associates. Then, somewhere in this cell, there must be a membrane which is permeable to water, hydrogen ion, and the halide ions, but to essentially nothing else. I say halides generically rather than chloride ion alone, because bromide and iodide, when injected into the blood stream as sodium salts, also appear in the gastric juice as HBr and HI in place of part of the HCl. The existence of such a uniquely specific membrane is not difficult to conceive of, in the light of what we already know about semipermeable membranes in general. It may constitute part of the outer cell membrane or the walls of the intracellular canaliculi, which several microscopists believe to be artifacts but which have been accepted by others on reasonably good evidence.

Such a membrane must exist in order for the cell to effect a complete separation of hydrogen ion from all the metal cations. So far as I know, the other theories about HCl formation make no attempt to explain this quantitative separation, although it is one of the most important steps in the process. The several theories that postulate the secretion of a neutral chloride which undergoes hydrolysis *after* it leaves the cell predicate a reabsorption of ammonium hydroxide or of an alcohol of high molecular weight in the neck of the gastric gland, but not of the HCl. If such a differential reabsorption is possible, then I suppose sodium ion and the other cations can also be reabsorbed under these circumstances. But how can the H ion, which possesses the highest ionic mobility known in aqueous solution, not be able to penetrate a membrane at all when the other cations, which possess considerably lower mobilities, are able to penetrate it completely? I think this premise of postsecretory hydrolysis is contrary to all current physicochemical thinking on the subject.

Let us therefore postulate the existence—as part of the parietal cell—of a membrane which is permeable only to water, H ion, and chloride or related ions. Then, consider what happens when some intracellular change takes place which energizes the cell to excrete water (Fig. 4). Some of this water moves out from the cytoplasm, through the cell membrane, and into the interstitial spaces. In so doing it takes with it the by-products of cellular activity and metabolism, along with the usual electrolytes, because the outer membrane of the parietal cell may be expected to resemble that of any other cell in this respect. But some of the water must also be forced out through the specifically permeable membrane of the intracellular canaliculus. In order to keep the osmotic work at a minimum—an invariable thermodynamic requirement in such a situation—the latter water will be accompanied by whatever solute is able to penetrate this membrane, that is H ion and Cl ion. So even though the hydrogen ion concentration of the cytoplasm is ex-

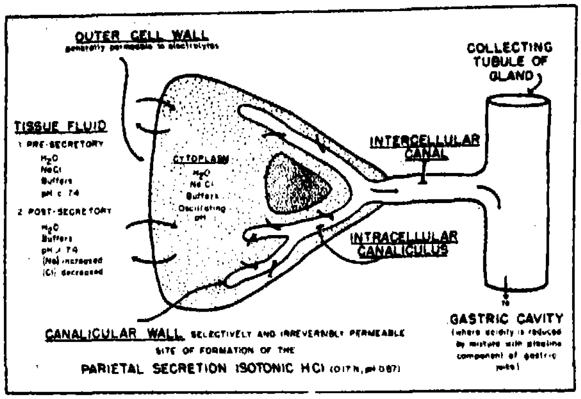
OUTER CELL WALL
generally permeable to electrolytes
COLLECTING TUBULE OF GLAND
TISSUE FLUID
1 PRE-SECRETORY
H_2O
NaCl
Buffers
pH c 7.4
2 POST-SECRETORY
H_2O
Buffers
pH > 7.4
(Na) increased
(Cl) decreased
CYTOPLASM
H_2O
NaCl
Buffers
Oscillating pH
INTERCELLULAR CANAL
INTRACELLULAR CANALICULUS
TO
GASTRIC CAVITY
(where acidity is reduced by mixture with alkaline component of gastric juice)
CANALICULAR WALL selectively and irreversibly permeable
site of formation of the
PARIETAL SECRETION ISOTONIC HCl (0.17 N, pH 0.87)

FIG. 4. Schematic representation of the process of HCl formation in the parietal cell of the stomach. The chemical reaction at the wall of the intracellular canaliculus may be written as follows, where B represents the usual cations:

$$BCl + H_2O \longrightarrow HCl + BOH$$

$$BOH + \left\{ \begin{array}{l} H_2CO_3 \\ BH_2PO_4 \\ \text{etc.} \end{array} \right. \longrightarrow H_2O + \left\{ \begin{array}{l} BHCO_3 \\ B_2HPO_4 \\ \text{etc.} \end{array} \right.$$

The over-all energy requirement of the process may be divided into the following components: 1) chemical work (in the cytoplasm and interstitial fluid); 2) electrical work (at the canalicular wall); 3) mechanical work (from the intracellular canaliculus to the open end of the gland tubule); 4) osmotic work (at the canalicular wall). Since the parietal secretion is essentially isotonic with the parietal cytoplasm, the osmotic work is zero.

ceedingly low, some of it will be transported across the membrane, into the lumen of the canaliculus in the form of HCl. Since these ionic movements will leave OH ion and Na ion behind, this reaction is in essence a hydrolysis effected by means of a membrane of highly specialized character, i.e., a membrane hydrolysis.

The HCl solution, passing through the membrane, may be an isotonic or a hypotonic solution, which subsequently undergoes concentration in the collecting tubule of the gland until it reaches osmotic equilibrium with the adjacent interstitial fluid. But the latter process would require two specifically permeable membranes instead of one, and a dual expenditure of energy—first to concentrate the isotonic cytoplasm by removal of a hypotonic HCl solution, and second to concentrate the latter by reabsorption of water. Hence it seems more likely that the HCl will tend to come out of the cell in the first place at a concentration which is isotonic with the parietal cytoplasm, and so keep the osmotic work of this process equal to zero and simultaneously obviate a secondary concentrating process in the collecting tubule. This isotonic concentration of HCl would be about 155 mM, except that probably the intracellular fluid is itself slightly hypertonic with respect to the blood stream, for reasons that I cannot go into here. Hence we may expect to find a value somewhat above 155 mM, which explains the limiting value of 165–170 mM actually found in animal experiments, and the slightly hypertonic freezing point depression. In short, granted the premise of a specifically permeable membrane, the logic of the situation seems to necessitate the secretion of a virtually pure HCl solution, free of all other cytoplasmic components, and possessing a constant concentration somewhat greater than 155 mM.

According to this picture, the acid is formed in or immediately adjacent to the canalicular wall, and its anion derives directly from the sodium and other chlorides of the cytoplasm. The immediate source of H ion appears to be the water, so that the reaction for this process may be written as a membrane hydrolysis of, for example, NaCl to HCl and NaOH. But the instant such alkali is liberated it will be neutralized by the several buffer systems present in cytoplasm. Some of the carbonic acid will shift to base bicarbonate, and a small amount of the latter will shift to carbonate; primary phosphate will be converted to secondary phosphate; and some of the intracellular proteins may be converted to alkali proteinate. The addition of NaOH to these buffer systems may possibly shift the intracellular pH a little to the alkaline side; if so, this will soon be readjusted by the excretion of the alkalinized buffers into the interstitial spaces, along with the products of cell metabolism. The excess NaOH, of course, will ultimately be excreted by the kidneys, after it has been balanced by reabsorption of the HCl in the small intestine.

Thus the membrane hydrolysis theory actually incorporates the theories of Maly, Bergeim, Bunge, and Robertson as essential but subordinate aspects of the over-all process. Even Davenport's carbonic anhydrase may play a role, in spite of his recent negation of it; the discrepancies between the magnitudes of certain inhibitory actions on enzyme activity and acid production may have no significance because the catalyzed formation of carbonic acid is only one of a group of reactions which are secondary to the primary actions of water transport and membrane hydrolysis. How we can bring Glick's ammonia-urease system into the picture, I cannot see as yet, but it will not surprise me at all if this should prove to be one of the mélange of intracellular reactions.

It is noteworthy that there is no evidence for a storage of concentrated neutral chlorides inside the cell. The movement of chloride ion from the blood stream and interstitial fluid to the parietal secretion appears to occur with great rapidity. As judged by the appearance of intravenously injected sodium iodide or radioactive chloride in the gastric juice, reported by other investigators, this entire passage from arteries to lumen of the stomach may require less than two minutes for its initiation. Evidently the cells are not susceptible to fatigue for any significant length of time. As long as there is an adequate supply of water and chloride, and an adequate removal of waste products, acid production will continue even though other tissues in the body may give evidence of salt depletion. This has been demonstrated by other workers, with animals kept on restricted salt intake for prolonged periods of time.

One might speculate at length about the cellular mechanics and energy requirement of the process of HCl formation, but as yet we have little evidence to work with. Although the osmotic work is zero, energy is certainly being expended in other forms—chemical work for hydrolysis and other reactions within the cytoplasm, electrical for transporting the solution across the canalicular wall, and mechanical for driving fluid out of the cell and through the intercellular canal and tubule of the gland proper. There is already some evidence that the energy can be supplied by glucose, but steps in the conversion are still a mystery. The entire process may be viewed as starting with the movement of water. Then fluid may be forced out because of local changes in hydrostatic pressure, or a pulsatory contraction of some specialized part of the cell, or even an intermittent reversible imbibition of an intracellular macromolecule, but these ideas are all pure fantasy at the present time.

And so I give you a picture of what may be happening in the parietal cell when it manufactures hydrochloric acid. I offer this, however, not as a statement of all that unquestionably occurs, but rather as a hypothesis for further investigation, and one which should be fruitful of many new approaches to the problem. The fact that this mechanism leads of necessity to many of the other theories which have already been advanced, and incorporates them as parts of itself by logical necessity, makes me hopeful of its essential validity. We are probably still far removed from knowing what kind of monkey wrench can be tossed into the parietal machinery for the therapy of ulcer disease, but I hope that this picture of its mechanism will make some contribution toward a simple medical solution of this most vexing clinical problem.

Based on the second annual Phi Delta Epsilon lecture, delivered at the University of Minnesota Medical School, November 3, 1948.

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The Inheritance of Sickle Cell Anemia[1]

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IF A DROP OF BLOOD is collected from each member of a randomly assembled series of American Negroes and sealed under a cover slip with vaseline, to be observed at intervals up to 72 hours, in the case of about 8 percent of the individuals composing the series a high proportion of the erythrocytes will be observed to assume various bizarre oat, sickle, or holly leaf shapes. This ability of the erythrocytes to "sickle," as the phenomenon is commonly described, appears to be attended by no pathological consequences in the majority of these individuals, and they are spoken of as having sicklemia, or the sickle cell trait. However, a certain proportion of the individuals who sickle are the victims of a severe, chronic, hemolytic type of anemia known as sickle cell anemia. This proportion has been variously estimated at between 1 : 1.4 (*8*) and 1 : 40 (*4*). The essential difference between sicklemia and sickle cell anemia appears at present to depend at least in part upon the relative ease with which sickling takes place. In sickle cell anemia the erythrocytes may frequently sickle under the conditions encountered in the circulating blood, whereas in sicklemia sickling does not usually occur under these conditions (*12*). This difference has been attributed to a greater tendency of the erythrocytes of sickle cell anemia to sickle when the O_2-tension is reduced, although recently this viewpoint has been challenged (*13*). Perhaps because of this difference—although there may be other factors involved, such as the aniso- and poikilocytosis to be observed in some individuals with the disease, and a greater resistance to hemolysis of trait cells when sickled than sickle cell anemia cells when sickled—the erythrocytes of a patient with sickle cell anemia have a greatly shortened life span, both in the individuals with the disease and in normal persons who have been transfused with the cells of sickle cell anemia patients, whereas sicklemia erythrocytes have an normal life span (*3, 14*).

The ability of the red cells to sickle was observed to have a genetic basis not long after sickle cell anemia was recognized as a clinical entity (*5*). On the basis of a study of one large family, Taliaferro and Huck (*15*) postulated that the ability to sickle was due to a single dominant gene. At that time the clinical distinction between sicklemia and sickle cell anemia had not been clearly drawn, and the inference was that this gene was more strongly expressed in some individuals (sickle cell anemia) than in others (sicklemia). This has remained the accepted hypothesis up to the present time. Several years ago the author, in a review on the clinical detection of the genetic carriers of inherited disease (*9*), was led to suggest an alternative hypothesis—namely, that there existed in Negro populations a gene which in heterozygous condition results in sicklemia, and in homozygous condition in sickle cell anemia. This hypothesis has a counterpart in the relationship which has been demonstrated to exist between thalassemia major and minor (*10, 16*). Recently the opportunity has arisen to give this hypothesis a thorough test.

There exist a number of arguments permitting a critical decision between the two hypotheses. The present preliminary note will consider only one of these arguments. If the homozygous-heterozygous hypothesis is correct, then both the parents of any patient with sickle cell anemia should always sickle (barring the occasional role of mutation; see below). If, on the other hand, the disease is due to a dominant gene with variable expression, only one parent need sickle, although occasionally, due to the chance marriage of two sicklers, both parents may sickle. In calculating the exact proportion of sicklemia to be expected among the parents of individuals with sickle cell anemia according to the dominant hypothesis, certain assumptions must be made. To the best of the author's knowledge, the question of the phenotype of the homozygote has never been raised by those who have accepted the variable dominant hypothesis of sickle cell anemia. For purposes of calculation we shall assume that under the variable dominant hypothesis all homozygotes have sickle cell anemia—alternative assumptions, such as intra-uterine lethality, are possible. We shall further assume that one in fifty heterozygotes also develops sickle cell anemia. Finally, we shall assume on the basis of the clinical data that the fertility of those with sickle cell anemia approximates 20 percent of normal, with the result that only a few individuals with this disease—so few

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[1] This investigation was supported in part by a grant from the U. S. Public Health Service. The study has been possible only through the generous cooperation of the Anemia Clinic of the Children's Hospital of Michigan, Detroit, Michigan, The University Hospital of the University of Michigan, Ann Arbor, Michigan, and the Wayne County General Hospital and Infirmary, Eloise, Michigan; all three institutions have made their case records of sickle cell anemia freely available. It is a pleasure to acknowledge my indebtedness to Mrs. Marion Weyrauch for technical assistance, and to Mrs. Laura Williams for case work.

that they may be disregarded in so rough a calculation—have one or both parents who are likewise affected. With these assumptions we may calculate, as shown in Table 1, that the proportion of sickling among the parents of individuals with sickle cell anemia should be 0.765. If one assumes that more than one in fifty of the heterozygotes develop sickle cell anemia, or that the homozygote is lethal, then the proportion of sickling parents should be even lower.

TABLE 1

CALCULATION OF THE PROPORTION OF SICKLING TO BE EXPECTED AMONG THE PARENTS OF INDIVIDUALS WITH SICKLE CELL ANEMIA ACCORDING TO THE VARIBLE DOMINANT HYPOTHESIS*

Type of marriage	Frequency of marriage	Frequency of offspring of the indicated genotype			Sickle cell anemia patients	
		Sk Sk	Sk sk	sk sk	Proportion in general population	Proportion among total anemia patients
One sickler parent (Sk sk × sk sk)	2 × 0.08 × 0.92 = 0.1472	.....	0.0736	0.0736	0.02 × 0.0736 = 0.001472	0.4693
Two sickler parents (Sk sk × Sk sk)	0.08 × 0.08 = 0.0064	0.0016	0.0032	0.0016	0.0016 + (0.02 × 0.0032) = 0.001664	0.5307
Total					0.003136	1.0000

* The assumption is made that all individuals homozygous for the sickling gene (Sk) develop sickle cell anemia, as do 1 in 50 persons heterozygous for the gene, and further that individuals with sickle cell anemia reproduce so infrequently that no significant error is introduced by their omission.

Expected proportion of sickling parents = (proportion of patients having *one* parent sickler) × (proportion of sicklers among these parents) + (proportion of patients having *both* parents sicklers) × (proportion of sicklers among these parents) = 0.4693 × ½ + 0.5307 × 1 = 0.765.

Thus far we have tested 42 parents of 29 patients with sickle cell anemia for the occurrence of sickling. In 13 instances both parents were studied and in 16, only one. Tests have been conducted in a variety of ways; especial reliance has been placed on a combination of the techniques described by Scriver and Waugh (*11*) and Hansen-Pruss (*7*), whereby a tourniquet is applied to a finger for 3–5 minutes, and then a drop of static blood from the finger is placed on a slide to which a small amount of Janus green or methylene blue has been added, and it is quickly covered with a cover slip which is sealed with vaseline. Observations are made at intervals up to 72 hours. Five preparations have been made for each individual. Every parent tested to date has sickled. This is the result expected from the homozygous-heterozygous hypothesis outlined above. On the other hand, the probability of the occurrence of such a number of positive parents under the variable dominant hypothesis is $(0.765)^{42}$, or 0.000013.

There are to be found in the literature a number of reports where one or both parents of a child with sickle cell anemia have been tested and found not to sickle (review in reference *9*). The results of tests for the sickling phenomenon are known to be variable; it is felt that the experience quoted may be explained in terms of lack of familiarity with the techniques necessary to elicit sickling.

The approximate frequency of the gene responsible for sickling in the American Negro (p) may be determined from the equation $2p\ (1-p) = 0.08$. Solution of this equation yields a p value of 0.042, from which the incidence at birth of this chronic, disabling, and fatal disease among American Negroes may be placed at $(0.042)^2 = 1.8$ per 1000.[2] The ratio among Negro births in the United States of those with sicklemia to those who will develop sickle cell anemia should therefore be approximately $80:1.8 = 44:1$; in the Negro population as a whole the ratio of sicklemia : sickle cell anemia is significantly higher because of the greater mortality among those with sickle cell anemia. In Africa, the incidence of sickling has been reported to vary from approximately 12 percent in Northern Rhodesia (*1*) to 17 percent in the Gold Coast Negroes and 19 percent in natives of Nigeria and the Camaroons (*6*). This would correspond to a gene frequency of approximately 0.064–0.106, and a frequency of the homozygote of 4.1–11.2/1000. The complex and fascinating problems in gene dynamics raised by frequencies of this order will be dealt with in another paper.

In a genetic situation such as appears to obtain here, where the heterozygote, who may be termed the genetic carrier of the disease, may be readily distinguished from normal and from the homozygote, it is possible to predict with a high degree of accuracy which marriages should result in homozygous individuals—in this case, children with sickle cell anemia. Since (homozygous) individuals with sickle cell anemia either die young or, if they reach maturity, have a greatly lowered fertility, the vast majority of cases of the disease are the issue of marriages between two (heterozygous) persons with the sickle cell trait. In the absence of marriage between individuals whose erythrocytes exhibit the sickling phenomenon, the frequency of the homozygote would greatly decrease, and sickle cell anemia would tend to disappear, with only a very rare case arising as a result of mutation in a normal individual married to a person homozygous or heterozygous for the sickling gene.

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[2] The correct formula is $y = a\ p + (1-a)p^2$, where a = the mean coefficient of inbreeding. The value of a for the American Negro is unknown, but probably quite small, in the neighborhood of 0.0005. For present purposes the value of p^2 is a sufficiently close approximation to y.

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TECHNICAL PAPERS

New Sectioning Techniques for Light and Electron Microscopy

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The application of the electron microscope to many biological problems has been seriously hampered by the lack of a rapid practical method of cutting uniformly thin sections having adequate area and integrity of structure. Because of the very slight penetrating power of the beam in commercial electron microscopes and the great relative depth of field involved, specimen structure is difficult to interpret when sections are over a fraction of a micron in thickness.

Although various solutions to this problem have been described in the literature, their success and general application have been limited. A departure from classical approaches to the problem has been the high speed microtome (*2*, *3*). However, this precision equipment is not only expensive and complicated but produces a low percentage of usable sections. Moreover, the sections are cut so rapidly and abundantly that selection is time-consuming and uncertain. Several workers (*1*, *5*) have described a technique which uses the thinnest portions of wedge-shaped sections for electron microscopy. Their methods, however, have been laborious and difficult to reproduce.

The most recent effort has been that of Pease and Baker (*4*), who have used standard histological techniques to embed tissue in collodion and paraffin. For sectioning, they altered a Spencer rotary microtome so that the unit of advance was reduced to approximately one-tenth the calibrated value. The microtome was then reported to produce sections as thin as 0.1 μ. Many workers, however, have had trouble in using their technique, mainly because of the exacting demands made on the microtome-advancing mechanism. Another disadvantage has been the difficulty of making very thin sections with the standard embedding media, such as paraffin and collodion.

In recognition of this problem, a promising new development in ultramicrotomy is presented. It consists of a method for obtaining extremely thin sections, involving the use of a methacrylic resin as an embedding medium, a thermal expansion device for advancing the specimen in a commercial microtome, and metallic shadow-casting for increasing observable detail in some of the sections. These techniques form the basis of a new method for producing numerous thin sections suitable for obtaining transmission images at the higher magnifications in the conventional light, phase-contrast, and electron microscopes. Polymerization of *n*-butyl methacrylate provides a rapid and simple means for embedding the fixed biological material in a solid resin. This gives an optically clear matrix from which the sections are cut, one at a time. Smooth, continuous advance of the embedded

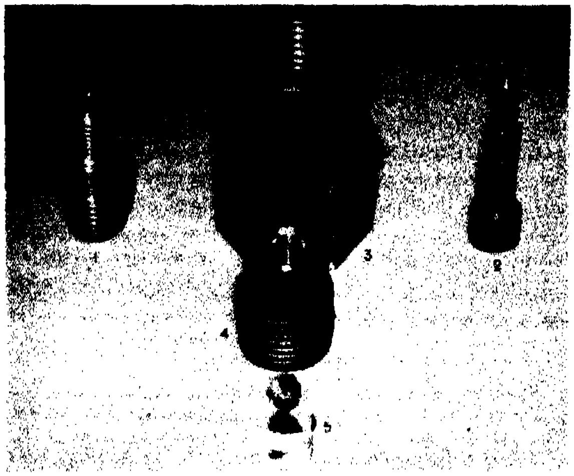

FIG. 1. Disassembled thermal expansion apparatus: (1) and (2) needle valve for carbon dioxide gas, (3) brass expansion chamber tapped for the fittings, (4) standard 3/8-in. brass pipe plug with cavity in face to seat embedded tissue, and (5) tissue in the clear resin with gelatin capsule removed.

specimen toward the knife is effected by the thermal expansion of a brass specimen holder, which permits the Spencer microtome, with its advancing mechanism disengaged, to cut ultrathin sections having uniform thickness, large area, and integrity of tissue structure.

Before being embedded in the polymer, the tissues are fixed and then dehydrated in an ethyl alcohol series by the usual cytological techniques. From absolute alcohol they are transferred to a solution containing equal volumes of absolute alcohol and pure monomeric *n*-butyl methacrylate from which the inhibitor has been removed. After about 1 hr in the alcohol-monomer mixture, the tissues are put in the monomer alone for an equal period. To ensure removal of the alcohol, they are then placed in two additional changes of monomer for at least 1 hr in each.

No. 00 gelatin capsules are convenient embedding molds. The main body of the capsule is set upright in a wooden block or other base and filled with the monomer, to which has been added 1% (by weight) of a catalyst (2,4-dichlorobenzoyl peroxide). After the tissue is placed in the mixture, the capsule lid is slipped on to retard evaporation, and the assembled capsule is placed in an oven kept at a temperature of 45° to 50° C. For even heating, the capsules are suspended by strips of cellophane tape and good air circulation is maintained in the oven.

At the end of 6–8 hr the monomer is polymerized into a solid matrix containing the tissue embedded at the bottom of the clear plastic. An additional period of several hours at this temperature will ensure complete cure. After soaking in water, the gelatin capsule may be peeled from the resin.

An inexpensive device is used for holding and advancing the embedded specimen (Fig. 1). It is essentially a brass block containing a hole threaded at one end to receive a standard ⅜-in. brass pipe plug. A cavity drilled into the face of the plug provides a seat for the embedded specimen. Behind the plug is a needle valve, which admits compressed carbon dioxide. As the gas undergoes a large change in volume, it cools and contracts the assembly. Stopping or reducing the flow of gas allows the apparatus to approach room temperature again and thus provides continuous advance of the embedded tissue toward the cutting edge.

In practice, the embedded specimen is first cemented into the mounting block with a mixture of pure gum rubber and paraffin. Then, with the device clamped in the jaws of the microtome head, the entire assembly is cooled below room temperature. Upon the appearance of a thin layer of frost on the metal, the knife is adjusted so that the specimen just misses it on the cutting stroke. The specimen is then mechanically advanced at 2- or 3-μ increments until the first slice is made. At this point the mechanical advancing mechanism of the Spencer rotary microtome is disengaged by setting it to zero and the gas flow is reduced or stopped. After a few seconds the specimen can be cut again. Because the specimen is advancing continuously, a quick chopping stroke involving one complete revolution of the hand wheel is necessary. With a little experience one can soon judge the necessary time interval between cuts. Some control of the rate of specimen advance can be obtained by bleeding the carbon dioxide at various reduced rates into the expansion chamber.

Although polybutyl methacrylate has excellent cutting properties, the sections usually are found to be somewhat folded. They are lifted from the knife with a dry camel's hair brush, picked up with a dissecting needle, and placed on a water surface warmed on a hot plate to about 35° C. After a period ranging from a few minutes to an hour or more, many will flatten out on the surface and exhibit bright interference colors. These sec-

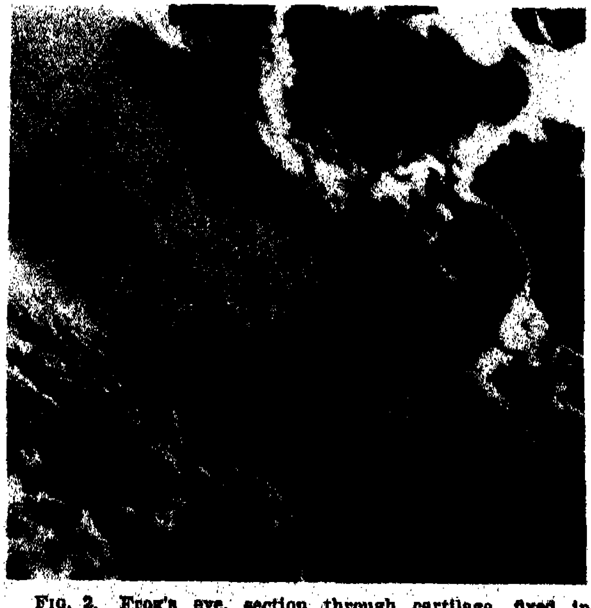

FIG. 2. Frog's eye, section through cartilage, fixed in Bouin's. Electron micrograph, total magnification × 10,400.

tions are then floated onto clean microscope slides and allowed to dry flat. Sections prepared for phase contrast microscopy are placed in acetone or toluene for about ½ hr to remove the matrix and are mounted in Canada balsam. For ordinary light microscopy the matrix is dissolved off and the section stained in the usual way.

FIG. 3. Dog kidney, tubules and glomerulus, fixed in Zenker-formol. Electron micrograph, total magnification × 1500.

In preparing material for the electron microscope, the sections are floated from the water onto clean glass slides and dried flat. The matrix is then dissolved out by placing the slide in acetone, toluene, or amyl acetate. A dilute solution of collodion in amyl acetate is allowed to flow over the slide bearing the tissue, which is then permitted to dry at room temperature. The collodion film containing the section is floated from the slide onto water, and the specimen-mounting screens of the electron microscope are placed over the area of the film containing the section in the usual manner.

Detection of structural details in some of the tissues was greatly improved by metallic shadow casting of the sections as described by Williams and Wyckoff (*6*). This process, of wide application in electron microscopy, produces a three-dimensional aspect as well as greater contrast in the structural details of the tissue.

The suitability of the sectioning technique for general use was determined by preparing a variety of biological tissues in several different fixatives (Figs. 2 and 3). Although this new method for obtaining very thin sections has given satisfactory results, it possesses certain limitations. Knife sharpness, for example, is of vital importance. However, the tilt of the knife during sectioning is not particularly critical. The greatest chance for failure appears to lie in the polymerization of the embedding mass. Use of low temperature catalysts and maintenance of a curing temperature of 45° to 50° C will usually prevent the formation of insoluble resins. Occasionally tissues are injured during the polymerization reaction and such tissues, which are easily detected, can be promptly discarded. For this reason, the use of fixing solutions with good hardening properties is recommended. While fixation artifacts remain problems for serious consideration, the new technique provides an inexpensive, practical method for producing ultrathin sections of tissue in almost routine fashion. Such a procedure should be of decided advantage in those fields of biology, medicine, and industrial technology which are concerned with the microstructure of materials.

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Protection of Lupulon and Humulon by Ascorbic Acid

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Lupulon and humulon, two antibiotics of known structure (*3, 4*) obtainable from hops (*6*), are of special interest because of their activity against *Mycobacterium tuberculosis* (*1*). Both are active *in vitro;* lupulon is active *in vivo* as well. Both show activity against several acid-fast organisms (*1*), against other Gram-positive bacteria (*4*), and against fungi (*2*). They lose activity, in part by oxidation, when boiled in aqueous solutions (*5*).

The possibility of increasing the stability of these substances was investigated for several reasons. It is desirable to have a method by which they can be heat-sterilized in water solution. Also, it has been noted that their antibiotic activity in nutrient media is often temporary, perhaps because of instability at incubation temperature. In brewing, humulon suppresses the growth of certain undesirable bacteria (*6*). However, nearly all of the lupulon and much of the humulon is inactivated during boiling of the beer wort (*7*). If these antibiotics could be adequately stabilized, their effectiveness would increase and their use might be extended to foods.

Humulon and lupulon were prepared as previously described (*2*). For preparation of aqueous solutions, 40 mg of the antibiotic was first dissolved in 1 ml of warm propylene glycol. Phosphate buffer (0.015 M, pH 6.5) was then added to give concentrations of 4 ppm of lupulon and 40 ppm of humulon. Appropriate controls showed that this amount of propylene glycol did not affect the results described below.

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[1] Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

These solutions, prepared with and without ascorbic acid, were adjusted to pH 6.5 and heat-sterilized as shown in Table 1. Controls were held at room temperature. An additional set was buffered at pH 8.5 with 0.015 M phosphate, similarly treated, and subsequently adjusted to pH 6.5.

The antibiotic solutions were then added to tubes of nutrient dextrose broth to give lupulon concentrations of 2, 1, 0.5, and 0.25 ppm; and humulon concentrations of 20, 10, 5, and 2.5 ppm. Each tube was then inoculated with one drop of a 1-day-old culture of *Staphylococcus aureus* (A.T.C.C. 6538 P) grown on nutrient dextrose broth. The tubes were examined after 20 hr, and visible turbidity was taken as a criterion of growth.

TABLE 1

PROTECTION OF LUPULON BY ASCORBIC ACID DURING HEAT STERILIZATION

Heat treatment	Concentration in ppm* required for complete inhibition of *Staphylococcus aureus* for 20 hr		
	No ascorbic acid	0.1% ascorbic acid	1.0% ascorbic acid
None	1	1	0.5
Flowing steam, 10 min	> 8	2	..
Autoclave, 10 lb, 10 min	> 8	1.5	1
Autoclave, 15 lb, 15 min	..	2	..

* Partial (roughly 50%) inhibition was usually obtained by one-fourth of this concentration.

Lupulon solutions containing no ascorbic acid always lost their activity when heated, while those containing ascorbic acid retained a large part of their activity (Table 1). These data represent samples buffered at pH 6.5 but similar results were obtained with the samples sterilized at pH 8.5.

Humulon solutions (buffered at pH 6.5 or 8.5) did not lose their activity when steamed for 10 min or autoclaved at 10 lb pressure for 10 min. Humulon was roughly 10% as active as lupulon against *S. aureus*, giving complete inhibition at 10 ppm and partial inhibition at 5 ppm.

These experiments were run with lupulon and humulon in sufficiently low concentration to permit complete solubility in the buffered solutions. When their concentrations (in pH 6.5 buffer) were increased 10-fold to 40 and 400 ppm, respectively, they were partly in solution and partly colloidally dispersed in the aqueous phase (although a higher solubility has been reported for other humulon preparations [*8*]). Under these conditions the ascorbic acid gave little or no protection. Further attempts to stabilize such dispersions were not made.

For comparison with heat sterilization, small samples of solutions containing 4 ppm of lupulon or 40 ppm of humulon were sterilized by passage through a "UF" fritted glass filter. Both lupulon and humulon solutions lost one-half to three-fourths of their activity during this process, and this loss was not prevented by the addition of ascorbic acid to the solutions.

To determine whether ascorbic acid protects lupulon and humulon during incubation, tubes were prepared containing these antibiotics and ascorbic acid as shown in Table 2. The medium was nutrient dextrose broth (pH 6.5). The ascorbic acid solutions were brought to this pH just before addition to the medium. The tubes were inoculated with *S. aureus* and incubated for 20 days; during this time they were examined at intervals for visible turbidity.

TABLE 2

PROTECTION OF LUPULON AND HUMULON BY ASCORBIC ACID DURING INCUBATION

Antibiotic	Concentration in ppm	Duration in days of complete inhibition of *Staphylococcus aureus*			
		No ascorbic acid	0.01% ascorbic acid	0.05% ascorbic acid	0.25% ascorbic acid
Lupulon	2	1	> 20	3*	> 20
"	1	1	3	5	> 20
"	0.5	0	0	1	5
"	0.25	0	0	0	1
Humulon	20	9	9	> 20	> 20
"	10	1	1	2	7
"	5	0	0	0.5	1
"	2.5	0	0	0	1

* The reason for this irregularity is unknown.

At each concentration of antibiotic, the time required for growth to appear (or the duration of antibiotic activity) increased with increasing concentration of ascorbic acid (Table 2). Presumably, this relationship was due to protection of lupulon and humulon by ascorbic acid, since ascorbic acid itself did not inhibit growth.

This protective effect is even evident after 1 day. The lowest concentrations of lupulon and humulon to give complete inhibition for 1 day without ascorbic acid were 1 and 10 ppm, respectively. In the presence of 0.25% ascorbic acid these were reduced to 0.25 and 2.5 ppm (Table 2). Without ascorbic acid, part of the antibiotic was apparently inactivated before a significant amount of growth could take place.

Since these antibiotics are known to be readily oxidized (*5*), a tentative explanation of these results is that ascorbic acid has retarded their oxidation.

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An Unusual Lacustrine Delta

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There are several possible approaches to the problem of land form classification. One of the most popular methods involves the gentic classification of forms that will be representative of types actually developed in the rocks and materials of the earth's surface. An attempt is made to establish the particular conditions which operate to produce similar land form types. Nature, however, is a great nonconformist and new types or variations of an old theme are not unusual in the field. Occasionally a particular land form expresses a contrary mood of nature, resulting in a truly unusual set of conditions. It is still possible to classify the type in most cases, but genesis may lie in violation of the usual explanation of origin.

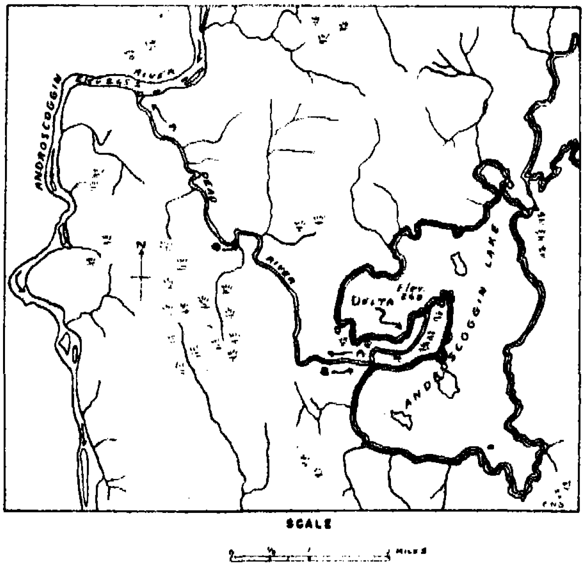

FIG. 1.

One such unique case is found in Androscoggin Lake near Leeds, Maine, about 2 miles southeast of Wayne. A lacustrine delta nearly 1.5 miles long and 0.25 of a mile wide is being built at the head waters of a stream called Dead River. Usually, one expects to find a delta at the mouth or outlet of a stream; at this locality, however, a delta is forming at the opposite end or source of the river.

Throughout much of the year the Androscoggin, one of of the larger rivers in Maine, flows south to the Atlantic Ocean: Dead River, tributary and outlet of Androscoggin Lake, flows northwest and empties into the Androscoggin River. On the sketch (Fig. 1), arrows indicate the direction of flow in the large river and similar arrows marked *A*, show normal direction of flow in Dead River. The difference in elevation between the water in Androscoggin Lake and the Androscoggin River is probably not more than 4–5 ft, and Dead River flows very sluggishly. In time of flood and high water on Androscoggin River, a considerable volume of water moves into the outlet of Dead River and the direction of flow is reversed, as indicated on the sketch map by arrows marked *B*. Water from the larger river then moves into Androscoggin Lake.

Reversal of flow on Dead River occurs generally in the spring months, when runoff is high, and large quantities of sand and silt are being carried by Androscoggin River. This load is obtained partly from the quantities of sand in the region through which the river flows. Surplus water spilling into Dead River—water laden with rock material—moves into the lake, where velocity is checked by the standing lake water and the load is dropped. This deposition normally occurs in similar fashion at the mouths of most streams where deltas are being built. In the case of the lacustrine delta at Androscoggin Lake, however, nature has played one of her pranks and heavy deposition takes place at the head or source of Dead River.

Thermostable Inhibition of Bacterial Hyaluronidases by the Serum of Normal Human Beings[1]

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Hyaluronidase, a mucolytic enzyme, and its substrate hyaluronic acid, a complex polysaccharide which is present in the intercellular substance of connective tissue, compose an enzyme system which appears to be involved in the pathogenesis of various infectious and rheumatic diseases (*2, 6*). Hyaluronidase is elaborated by various bacteria, and is present in spermatic fluid and aqueous extract of testicle. Since hyaluronidases are antigenic, there is current interest in the investigation of hyaluronidase inhibition by the serum of normal human beings and of patients with infectious disease and rheumatic fever. Specific inhibition of pneumococcus hyaluronidase by the immune serum of patients with bacteremic pneumococcus infections has been reported to be thermostable (*7*), whereas the inhibition of testicular hyaluronidase by the serum of normal, nonimmune human beings has been reported to be thermolabile (*1, 3, 4*). In contrast to the thermolability of the inhibitor of testicular hyaluronidase, this report indicates that the inhibitor of pneumococcus hyaluronidase in normal human serum is almost always thermostable, the inhibitor of staphylococcus hyaluronidase is usually thermostable, and the inhibitors of *Cl. perfringens* and streptococcus hyaluronidases may be either thermolabile or thermostable.

This study investigated the inhibition of similar test strengths of five hyaluronidases by the serum of 50 normal human beings who were between 20 and 40 years of age. Each serum was tested immediately as it was removed from the clot, and again after it had been heated at 56° C for 30 min. The hyaluronidases used in these tests were unrefined filtrates of cultures of type 3 *Pneumococcus*, hemolytic *Staphylococcus aureus*, *Clostridium perfringens*,[1] beta hemolytic *Streptococcus* (group A),[2] and purified bovine testicular hyaluronidase. Twofold serial dilutions of each serum were titrated against the constant strength of each enzyme. Hyaluronidase inhibition was measured by the mucoprotein clot prevention test as previously described (*7*), except that fresh egg albumin was used instead of normal horse serum as the protein component of the substrate. With this modification of the test, a fourfold variation of serum inhibition titer could occur by chance, so that eightfold variation of titer was considered significant. If a 1: 3 dilution of a serum did not inhibit an enzyme, inhibitor was considered to be absent from the serum. Hyaluronidase inhibition by serum was considered thermostable if heating the serum caused no significant fall in the titer.

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[1] Supported by a grant from the Robert Gould Research Foundation. This article has been published in abstract (*Fed. Proc.* 1949, 8, 372).

Before heating the sera at 56° C for 30 min, all inhibition of the five hyaluronidases by normal sera occurred in a serum dilution of 1: 48 or less, except that two sera in dilution of 1: 192 and four sera in dilution of 1: 96 inhibited the pneumococcus hyaluronidase, one serum in dilution of 1: 384 inhibited the staphylococcus hyaluronidase, and one serum in dilution of 1: 96 inhibited the streptococcus hyaluronidase. Results tabulated below reveal thermostable inhibition of the five hyaluronidases by normal sera:

TABLE 1

Hyaluronidase tested	No. of sera tested	No. of inhibiting sera before heating	No. of thermostable inhibiting sera
Pneumococcus	50	47	45
Staphylococcus	49	23	19
Cl. perfringens	50	16	10
Streptococcus	50	12	7
Testicular	48	46	2

Tests upon consecutive daily sera of four persons revealed consistent inhibition of the pneumococcus, staphylococcus, and testicular hyaluronidases. However, there was day-to-day fluctuation in the inhibition of the streptococcus and *Cl. perfringens* hyaluronidases, so that results of the inhibition of these two enzymes tabulated above are of undetermined immunological significance.

A further preliminary investigation of the thermolabile serum inhibition of *Cl. perfringens*, streptococcus, and testicular hyaluronidases was carried out. After this inhibition had been destroyed by heating the sera at 56° C for 30 min, it was completely restored in most sera and partially restored in remaining sera by the addition of complement (*5*). The complement used was 0.5 cc of a 1: 30 dilution of normal guinea pig serum, which alone did not inhibit the test strength of the enzymes.

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Vitamin B_{12} and Cobalt Deficiency in Sheep

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The discovery by Rickes *et al.* (*2*) that vitamin B_{12} is a cobalt complex pointed to the possibility that this vitamin was an intermediary in the metabolism of cobalt in those species requiring this element. It has been suggested by several workers that cobalt, which is known to be required by ruminant but not by nonruminant animals, functions primarily through some unknown mechanism in the rumen, probably related to the microflora. This theory enjoys some but not conclusive experimental support.

At the time that the report of Rickes *et al.* appeared, we were engaged in studies of cobalt deficiency in lambs. Among the symptoms displayed by these lambs were loss of appetite, anemia, loss in body weight, and eventual death. Such symptoms have previously been reviewed by Russell (*3*). Among the treatments under study were the effects of cobalt administration by feeding vs. injection. It was observed that deficient lambs when fed 1 mg of cobalt per day responded quickly in improved appetite, gains in weight, and increase in hemoglobin concentration of the blood. On the other hand, deficient lambs when injected with the same quantity of cobalt showed no detectable response over a period of 7 weeks. It thus seemed possible, assuming that vitamin B_{12} is a necessary metabolite for sheep, that cobalt orally administered may be synthesized into vitamin B_{12} by the rumen flora; and that cobalt injected was incapable of this transformation, possibly because insufficient quantities of it reached the rumen Comar *et al.* (*1*). According to this postulate cobalt deficiency is essentially a vitamin B_{12} deficiency and if this vitamin is furnished the deficient animal directly by injection, a favorable response should follow. Since cobalt salts injected into deficient lambs gave no response it seemed safe to assume that the much smaller amount of cobalt present in vitamin B_{12} would not give a response *per se*.

Cobalt-deficient lambs which had previously been injected with cobalt salts were chosen for this study. All of these lambs had pronounced symptoms of cobalt deficiency. They were injected with various amounts of crystalline vitamin B_{12}[1]. The injections were made in-

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[1] This hyaluronidase was glycerol-dialyzed. It was prepared and supplied by Dr. A. A. Tytell, Cincinnati, Ohio.

[2] Culture supplied by Dr. R. M. Pike, Dallas, Texas.

TABLE 1

HEMOGLOBIN LEVELS OF COBALT-DEFICIENT LAMBS TREATED WITH VITAMIN B_{12}

Sheep No.	B_{12} treatment	Dosage	Hemoglobin level (g/100 ml) Pre-treatment	1st week	2nd week	3rd week	4th week	5th week
		(µg/week)						
1	Crystalline—injection	2	7.1	6.3	died			
17	Crystalline—injection	6	5.2	3.3	2.7	re-moved		
7	Crystalline—injection	9	4.4	6.0	5.6	5.7	6.0	6.2
9	Crystalline—injection	large*	6.0	4.9	6.0	4.9	4.9	4.9
7	Orally—concentrate	30	6.3	6.2	5.8	6.2†	6.6	6.6
7	Orally—concentrate	120	4.9	4.4	4.2	4.6†	5.7	6.6

* Single injection of 25 µg followed by another of 100 µg during second week.

† Initial dosage doubled.

TABLE 2

AVERAGE DAILY WEIGHT GAIN OF COBALT-DEFICIENT LAMBS TREATED WITH VITAMIN B_{12}

Sheep No.	B_{12} treatment	Dosage	Average daily gain (lb/day) 1st week	2nd week	3rd week	4th week	5th week	6th week
		(µg/week)						
1	Crystalline—injection	2	*	*	died			
17	Crystalline—injected	6	.34	*	*	re-moved		
7	Crystalline—injected	9	.54	.27	.13	.07	*	*
9	Crystalline—injection	large†	*	.06	.29	.33	*	*
7	Concentrate—orally	30	.03	*	.19‡	.29	*	.36
9	Concentrate—orally	120	*	.23	*‡	*	*	*

* Lost weight for the period.

† Single injection of 25 µg followed by another of 100 µg during second week.

‡ Initial dosage doubled.

tramuscularly twice per week during the period of treatment. Following the period of injections, two lambs were kept under study and fed vitamin B_{12} concentrate.[1]

The levels of vitamin B_{12} chosen for treatment were quite arbitrary, since we had little to guide us from the literature. West (*4*) reported favorable responses in pernicious anemia patients injected with single doses of 3.6 and 150 µg, indicating that the compound had high biological potency.

Results following vitamin B_{12} therapy, in terms of hemoglobin levels and weight gains in lambs, are summarized in Tables 1 and 2. It is noted that there was no significant response in these cobalt-deficient lambs when injected with crystalline vitamin B_{12} in amounts as high as 125 µg. The number of observations was necessarily small since the supply of vitamin B_{12} was very limited; however, the results were clearly negative. Neither was there a response in those lambs fed the vitamin B_{12} concentrate over a period of 6 weeks. Although the concentrate contained cobalt the amount was apparently too small to give a response to cobalt *per se.*

These preliminary and limited observations give no support to the theory that vitamin B_{12} is an important intermediary in cobalt metabolism in lambs.

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Synthesis of Tris(monofluorophenyl) methane and Tris (parafluorophenyl) methane

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In our search for a liquid dielectric, many aromatic fluorides were prepared in our laboratories, using the Balz-Schiemann (*1*) reaction. These compounds were also coupled by condensation reactions, or by Friedel and Crafts reactions, into symmetrical or unsymmetrical complex molecules.

The preparation of triphenyl methane from benzene and carbon tetrachloride with anhydrous aluminum chloride progressed with such ease and with such good yields (68–84%), that the Friedel and Crafts reaction was used to synthesize substituted triphenyl methane molecules with fluorine in the benzene rings.

Tris(monofluorophenyl) methane was synthesized by reacting 3.5 moles of monofluorobenzene and 1 mole of carbon tetrachloride with anhydrous aluminum chloride according to the procedure for the preparation of triphenyl methane as described and explained by J. F. Norris (*2*). The mechanism of the synthesis accordingly would be:

$$3\ C_6H_5F + CCl_4 + AlCl_3 \longrightarrow (C_6H_4F)_3CCl \cdot AlCl_3 + 3\ HCl$$

$$(C_6H_4F)_3CCl \cdot AlCl_3 + (C_2H_5)_2O \longrightarrow (C_6H_4F)_3CH + CH_3CHO + C_2H_5Cl + AlCl_3$$

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[1] Supplied through the courtesy of Merck and Company.

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This reaction proceeded smoothly and the product was a liquid rather than a solid like triphenyl methane. The liquid was oily, water-white, and sweet-smelling. In reflected light it exhibited a violet fluorescence. It distilled over in a range of 200–210° C under 125 mm of pressure. The fact that it was a liquid was attributed to the possibility that it might be not a pure compound but a mixture of isomers. Further studies are being made on this point.

p-Difluorobenzene in a similar Friedel and Crafts reaction should form a pure compound and not a mixture of isomers. With the fluorine atoms in the para position in the benzene ring any linkage with the central methane carbon is ortho to one of the fluorine atoms and meta to the other. Since no other linkage is theoretically possible, a pure crystalline compound should result.

Using the same mole concentration as in the previous preparation but substituting *p*-difluorobenzene in the place of monofluorobenzene, the reaction progressed smoothly and gave an over-all yield of 45% of tris(*p*-difluorophenyl)methane. The product obtained was a yellowish crystalline solid. After three recrystallizations from 20 to 30% alcohol, pure white crystals were obtained. The mp of the pure crystals was 98.0–98.5° C.

Analysis (by H. S. Clark, Urbana, Illinois) for $C_{19}H_{10}F_6$:

	Calculated	*Found*
C	64.78%	64.94%
H	2.86%	2.86%
F	32.36%	32.20% (by difference)

The experimental details for these compounds will be reported shortly.

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Measuring the Thickness of Very Thin Microtome Sections

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Several authors have recently described methods of sectioning biological material for electron microscopy. Some have used a high speed microtome (*3, 4*), others a microtome at ordinary speed with various modifications (*1, 2, 5, 7*). It seems desirable to have sections at least as thin as 0.1 μ, while standard methods result in sections only as thin as 2 μ, or at best 1 μ.

During the war the writer developed a method for cutting some materials consistently at 0.05 μ and even less. Examination of these sections with the electron microscope failed, in the writer's opinion, to show the desired detail in the chromosome material in which he was interested, and so the work was discontinued. The method consists essentially in the use of: a purified and very hard wax (carnauba) at a low temperature, a specially constructed microtome of the rocker type at ordinary speed, and a beryllium bronze blade. Beryllium bronze is not very hard (about Brinell 380) but its texture is very uniform and it is easy to secure an extremely even and sharp edge. While the method did not succeed in the purpose for which it was intended, it might prove helpful with other materials. The author hopes to publish a full description of it soon. During this work, a simple and accurate means was found for measuring the thickness of the sections. As this may be generally useful, it is described herein.

Fig. 1. A sphere of wax resulting from the melting of a section on a thin glass fiber. The length of the scale is 0.1 mm.

Several optical methods are available for measuring thin films (*6, 8*), but their use is difficult when the area of the section is only of the order of a square millimeter. A much simpler way is to measure under the microscope the area of the section, then to melt the section into a sphere from whose diameter the volume of wax can be calculated (Fig. 1). To obtain the sphere, the section is caught on a very thin (less than 10 μ) glass fiber, and the fiber is mounted in the field of a binocular. A small loop of electrically heated wire is carefully guided close to the section, which is slowly melted. If the glass fiber is thin enough, an almost perfect single sphere will result; for greater accuracy one may prefer to calculate its volume as an ellipsoid. It is important to watch the heating under fairly high magnification, and to heat slowly, as too high a temperature will cause evaporation.

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Comments and Communications

Ground Substance of the Mesenchyme and Hyaluronidase: A Symposium[1]

The most salient characteristic of this symposium was that of unity underlying a great variety of subjects. For whatever success it achieved was due to the excellent contributions of workers from such diverse fields as chemistry, enzymology, histology, physiology, bacteriology, pharmacology, and clinical medicine. All contributions were fundamentally interested in an enzyme-substrate reaction taking place in the ground substance of the mesenchyme. This was, until recently, an almost abstract conception which now has become a well-defined entity, studied from every angle.

During the last twenty years, catalyzed by the discovery of the spreading factors and important advances in the chemistry of polysaccharides, and through the efforts of many investigators, the newer knowledge of the ground substance has come into prominence. The identification of hyaluronic acid, a component of the ground substance and the substrate upon which some of the spreading factors act, placed a number of these spreading factors in the category of enzymes. In the interim, independent workers studied with excellent results the morphology and physiology of interfibrillar structures. From these contributions, as coordinated in the conference, the ground substance emerged as a coherent unit which, although a part of all organs and tissues, has its own physiognomy and functions; and knowledge thereof appears indispensable for a full understanding of many physiological and pathological phenomena.

The conference was planned and developed along the lines that would seem to be the logical ones to follow in the discussion of a medical subject; that is, it began with chemical and morphological data, passed from this into physiological and pathological subjects, and ended with the clinical applications. Needless to say, this was not the chronological order in which the topics discussed have been studied, since progress in some frequently has been the result of what was already known of the others. As a matter of fact, it was quite revealing in respect to the unity of the symposium that in the great variety of excellent contributions authors rarely kept strictly to specialized fields; cross references were thus numerous and yet discrepancies were minimal.

The first section dealt with fundamental data on the ground substance of the mesenchyme and thoroughly covered the subject. K. Meyer, the chairman, gave a lucid preliminary survey of the mucopolysaccharides of the interfibrillar substance of the mesenchyme. He presented data on the state of hyaluronic and chondroitin sulphuric acids in tissues, and on the physical and chemical properties of these acids. These observations were complemented and extended by the electron microscope studies of Gross, who gave visual representations of the components of the ground substance. Alburn and Williams discussed sources and preparation of hyaluronic acid. A number of histochemical contributions followed. They comprised general studies of the mucopolysaccharides in a great variety of tissues (Bunting, McManus); of the changes in cells and intercellular substances after injection of testicular extract (Bensley); and of comparable changes following inoculation of gonadotropic hormones, and occurring in some pathological conditions such as cancer (Catchpole). It was revealed by these studies that the ground plasm is a dynamic system, changing continuously under the influence of a great variety of factors. In addition, these contributions paved the way for a clearer understanding of the physiological condition existing in the ground substance of the connective tissue. McMaster described it as a viscid medium through which the movement of matter takes place. The section ended with papers dealing with the accumulation of hyaluronic acid in the skin under two extreme conditions of hormone stimulation: in the pretibial edema of Grave's disease (Watson and Pearce); and in the sex skin of monkeys (Duran-Reynals, Bunting, and van Wagenen).

The next section was concerned with the permeability of the ground substance in infection and other conditions. D. H. Sprunt was chairman. The section opened with discussions by Dorfman, Meyer, and Tolksdorf, *et al.* on *in vitro* effects of hyaluronidase. The different modes of action of the enzyme, depending on the linkages of the molecule of the substrate, and the kinetics and specificity of the reactions were reviewed, and the need for establishing a hyaluronidase unit was emphasized. This was followed by a general discussion by Hechter on spreading factors and their mechanism of action, in both the living and the dead animal. The presence of hyaluronidase in inflamed skin was described by Meyer. The importance of bacterial enzymes acting on digestive tract and respiratory mucins (Burnet) was reviewed briefly by Briody. An interesting discussion developed concerning the effect of preparations containing hyaluronidase and other enzymes on the permeability of blood vessels, opposite views being maintained by Zweifach and Chambers on the one side, and by Elster on the other.

With all of these contributions as a background, the conference entered into the important field of the ground substance in infection. A general survey of the subject, covering the effects of mucolytic enzymes, of hydration and dehydration, and of hormones and other agents on the ground substance was given by Sprunt, and Opsahl, White, and Duran-Reynals. This was followed by contributions by Sallman and Birkeland, and by Pike on the production of enzyme and substrate by streptococci, and the meaning of these phenomena in infection. The concept emerged that infection is closely conditioned by a variety of physiological factors which find a direct expression in the permeability of the ground substance. Fluctuations in this permeability result in corresponding fluctuations in the severity of the infectious process. Estrogens and gonadotropic and adrenocortical hormones are especially potent in this connection.

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[1] Held December 3 and 4, 1948, under the sponsorship of the New York Academy of Sciences. Proceedings will be published in full in *The Annals of the New York Academy of Sciences.*

The same general topic on the permeability of the ground substance in infection was continued in the following section. M. Lurie, section chairman, gave an excellent general discussion of the mechanisms affecting spreading in infection, particularly in tuberculosis, in which connection he reported his studies on the paramount influence of constitution, sex, hormones, and still other factors on the disease. After this there followed a series of papers on that puzzling phenomenon of the inhibition of hyaluronidase by blood serum (Dorfman, Hadidian), and on the action of antibodies against streptococcal hyaluronidase (Friou, Quinn), which has proved to be an excellent diagnostic aid in streptococcal infections. The newer theories concerning the possible role played by the streptococcal enzyme or substrate in the pathogenesis of rheumatic disease were discussed. The subject was developed by Ragan and Meyer and discussed by Harris. Facts of great interest emerged in the discussion of this controversial subject—e.g., on the condition of the synovial fluid and the variations in the blood inhibitor for hyaluronidase in rheumatic disease.

In the field of cancer, promising results were reported by Simpson on the influence of hyaluronidase in malignant invasion of tissues, and by Fulton, Marcus and Robinson on an inhibitor for the enzyme found in cancer patients. These studies should be correlated with those of Catchpole, in the first section of the conference, concerning the water solubility of components of the ground substance around malignant growths. Another contribution by Anigstein described curious effects on typhus infection by antiorgan sera.

The last section was devoted to pharmacology and the practical applications of hyaluronidase. J. Seifter, chairman, reported results of his extensive studies on the enzyme, which he found to be pharmacologically nontoxic, and considers the perfect adjuvant, since it enhances the diffusion and thus speeds up the action of a variety of therapeutic agents. Warren and Burket and Gyorgy demonstrated the innocuousness of the enzyme in the case of established infection, in animals and humans respectively. Other authors reported the increased therapeutic effects obtained when hyaluronidase was added to local anesthetics (Kirby, Looby and Elkenoff); to penicillin (Sneierson); and to fluids used in hypodermoclysis (Burket and Gyorgy). The latter authors also reported comparable effects when the enzyme was added to dyes injected subcutaneously for diagnostic purposes.

The beneficial effects of hyaluronidase in some cases of human infertility as reported by Kurzrok offer the only instance of a direct therapeutic effect of the enzyme. To this one could perhaps add its dissolving action on renal calculi, as reported by Simon and Sussman. The effects on fertilization in men and cattle appeared to be a rather controversial subject, as discussed by Sallman and Birkeland and by Chang and Werthessen. The conference ended with these papers.

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Correction

My communication "Note on the Chemistry of Dramamine" (*Science*, 1949, **109**, 574) should have made it clear that the name "Dramamine" applies to the *salt* of β-dimethylaminoethyl benzohydryl ether with 8-clorotheophyllin. As it stands, the first sentence in the second paragraph of my note makes it appear that Dramamine is the ether alone, and that is incorrect.

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Book Reviews

Dentistry in public health. (Prepared for the Dental Health Section of the American Public Health Association.) Walter J. Pelton and Jacob M. Wisan. (Eds.) Philadelphia: W. B. Saunders, 1949. Pp. xi + 363. (Illustrated.) $5.50.

This book presents an unusually fine compendium of dentistry's role in public health. The collaborators have presented good summaries on the topics assigned to them. These summaries, although they are brief, contain the fundamental information which the student or the practitioner needs to develop his thinking in terms of public health service.

The extent of the dental health problem is fully outlined. The great number of people who need dental services, the time it takes to perform these services, and the limited dental man power add greatly to the complexity of the situation and cost of service.

The need for reparative as well as preventive and control service is stressed. Reparative service needs to be thought of as an initial service to care for possible accumulated neglect, and a maintenance service—suggesting regular periodic checkup and care after the initial service has been rendered. This makes the dental health problem a different one from others. The book offers a vast amount of information that should be of special interest to those in the field of dental health.

The role of nutrition and diet is discussed, as well as desirability of laboratory tests to evaluate oral conditions and caries activity. The effect of fluorine in water supply is well presented and indications are that this technique may become an effective agent in the control of dental caries. The topical application of sodium fluoride to the teeth is also considered.

The need for an effective plan of public dental health education is stressed. The desirability of local, state, and national participation in such a program of service—control and prevention—is well presented. Although now in its infancy, the role of dentistry in the public health program has unusual promise, as judged by the place the contributors to this book ascribe to it.

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Organic syntheses. (Vol. 28.) H. R. Snyder. (Ed.-in-Chief.) New York: John Wiley; London: Chapman & Hall, 1948. Pp. vi + 121. (Illustrated.) $2.50.

The present addition to the series of *Organic syntheses* maintains the high standards set by previous volumes. Directions for preparing the following 37 specific organic compounds are given: 2-acetothienone, 2-acetylfluorene, 9-acetylphenanthrene, 2-allylcyclohexanone, *o*-aminobenzaldehyde, *p*-aminophenyl disulfide, benzoyl disulfide, 9-bromophenanthrene, 4-bromo-*o*-xylene, 3-carbethoxycoumarin, *p*-chloroacetylacetanilide, *m*-chlorophenylmethylcarbinol, *m*-chlorostyrene, 9-cyanophenanthrene, *trans*-1,2-cyclohexanediol, 4,7-dichloroquinoline, 2,5-dihydroxyacetophenone, diisovalerylmethane, 3,4-dimethylaniline, 2,4-dimethylquinoline, 1,4-dinitronaphthalene, diphenylacetonitrile, ethyl azodicarboxylate, ethyl ethoxymethylenemalonate, fluorenone-2-carboxylic acid, hexamethylene chlorohydrin, hydroquinone diacetate, 2-hydroxycinchoninic acid. D,L-isopropylideneglycerol, methyl 4-keto-7-methyloctanoate, 4-nitro-1-naphthylamine, *p*-nitrophenyl sulfide, phenanthrene-9-aldehyde, 1-phenyl-3-amino-5-pyrazolone, α-phenylthiourea, 2,4,7-trinitrofluorenone, vinyl chloroacetate. In each case a check on the preparation has been made by a member of the editorial board and his collaborator. It may be of interest to several readers to record that for their convenience the *Chemical Abstracts* indexing name for each compound is given as a subtitle when that name differs from the title of the preparation. As is the usual practice in this series, the present volume also contains a collective index to material for Volumes XX–XXVIII.

Again, the editorial board should be complimented and congratulated upon its worthwhile project of continuing to make available a repository of miscellaneous syntheses of organic compounds which really work and which will present no unexpected difficulties to the student who needs to prepare one of them. This volume continues the invaluable service of developing good technique. The compounds, in the opinion of the reviewer, have been well selected and the discussions and notes at the end of each preparation are also a real contribution to this all-important field of organic chemistry. Thus, the original purpose of the series is being carried out ably.

Everett S. Wallis

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Scientific Book Register

Blout, E. R., Hohenstein, W. P., and Mark, H. (Eds.) *Monomers: a collection of data and procedures on the basic materials for the synthesis of fibers, plastics, and rubbers.* (Sect. 1.) New York: Interscience, 1949. 8 chapters. (Illustrated.) $7.50.

Carleton, H. M., and Leach, E. H. (Eds.) *Schafer's essentials of histology.* (15th ed.) Philadelphia: Lea & Febiger, 1949. Pp. xii + 655. (Illustrated.) $6.50.

Chalmers, J. Alan. *Atmospheric electricity.* New York (11): Oxford Univ. Press; Oxford, Engl.: Clarendon Press, 1949. Pp. 175. (Illustrated.) $3.75.

Hill, Frederick C. *Operative surgery.* New York: Oxford Univ. Press, 1949. Pp. xii + 698. (Illustrated.) $12.75.

Johlin, J. M. *Introduction to physical biochemistry.* (2nd ed.) New York: Paul B. Hoeber, 1949. Pp. ix + 246. (Illustrated.) $3.75.

Ledermann, Walter. *Introduction to the theory of finite groups.* New York: Interscience; Edinburgh-London: Oliver and Boyd, 1949. Pp. viii + 152. $3.00.

Leicester, Henry M. *Biochemistry of the teeth.* St. Louis, Mo.: C. V. Mosby, 1949. Pp. 306. (Illustrated.) $5.00.

Milne, William Edmund. *Numerical calculus: approximations, interpolation, finite differences, numerical integration, and curve fitting.* Princeton, N. J.: Princeton Univ. Press, 1949. Pp. x + 393. (Illustrated.) $3.75.

Page, Leigh, and Adams, Norman Ilsley, Jr. *Principles of electricity: an intermediate text in electricity and magnetism.* (2nd ed.) New York-London: D. Van Nostrand, 1949. Pp. xiii + 619. (Illustrated.)

Wright, Albert Hazen, and Wright, Anna Allen. *Handbook of frogs and toads of the United States and Canada.* (3rd ed.) Ithaca, New York: Comstock, 1949. Pp. xii + 640. (Illustrated.) $6.50.

Proceedings of the Fourth International Congresses on Tropical Medicine and Malaria: Washington, D. C., May 10–18, 1948. (Dept. of State, Publ. 3246, 2 vols.) Washington, D. C.: U. S. Govt. Printing Office, 1948. Vol. 1, pp. xiii + 946; vol. 2, pp. viii + 947–1810. (Illustrated.)

The situation in biological science: Proceedings of the Lenin Academy of Agricultural Sciences of the U.S.S.R., July 31–August 7, 1948. New York (16): International Pubs., 1949. Pp. 636. $5.00.

NEWS and Notes

Richard H. Young, dean of the College of Medicine of the University of Utah, has been made dean of the Medical School of Northwestern University. Dr. Young succeeds **J. Roscoe Miller,** who has been appointed president of the university.

Stanley D. Wilson, who has just completed twenty years as dean of the College of Science at Yenching University, is retiring this month and will return to the United States during the summer. Dr. Wilson arrived in China in 1917 to organize instruction in chemistry at the Premedical School of Peiping Union Medical College (Rockefeller Foundation), and later became professor of organic chemistry at the College of Science of Yenching University.

William A. Hinton has been appointed clinical professor of bacteriology and immunology at the Harvard Medical School. Dr. Hinton is director of the Laboratory Department of the Boston Dispensary, chief of the Wasserman Laboratory of the Massachusetts Department of Public Health, and special consultant to the U. S. Public Health Service.

C. J. Goodnight, of the Department of Biological Sciences, Purdue University, with his wife and a group of graduate students, left June 23 for Guatemala and southern Mexico to conduct ecological studies on the mammals, birds, reptiles, and animal parasites of tropical mountain communities. The expedition, financed by a grant from the Purdue Research Foundation, will be Dr. and Mrs. Goodnight's fourth research project in these regions. They will continue their work on tropical species of Phalangida in relation to the problem of continental drift.

Carl Voegtlin, former director of cancer research and retired chief of the National Cancer Institute of the U. S. Public Health Service, has been elected honorary member of the Swiss Academy of the Medical Sciences.

Roger Revelle, director of oceanographic research during the Bikini tests and resurvey, has been named associate director of the University of California Scripps Institution of Oceanography.

Isabelle H. Perry has resigned as director of the Department of Oncology of the Women's Medical College, Philadelphia, to accept a position as executive secretary of the Subcommittee on Oncology of the Committee on Pathology for the National Research Council.

Roy G. Hermann has been appointed head of the Biochemistry Section of the Research Laboratories of the Wm. S. Merrell Company, Cincinnati, Ohio.

Visitors to U. S.

Himansu Kumar Mitra, head of the Refractories Engineering Department of Tata Iron and Steel Company in India, visited Pittsburgh June 21–26 as part of a two-month tour of U. S. steel and refractories plants. He came here to attend the meetings of the Rotary International in New York City, to which he was the representative from India, and the Rotary Governors' International Assembly at Lake Placid. On his return trip, Dr. Mitra will spend several weeks in England.

Visitors at the National Bureau of Standards during the week of June 27–July 1 included: **A. J. A. Roux,** principal research officer, South African Council for Scientific and Industrial Research; **M. Escolano,** director, Instituto Tecnico de la Construcción y del Cemento, Madrid, Spain; **Realf Ottesen,** civil engineer, Norwegian Motor Engine Manufacturers Research Laboratory, Trondheim, Norway; **Anand N. Harkauli,** irrigation engineer with Irrigation Department, United Provinces, India; and **Gordon W. Collett,** chief chemist, Wanderlich, Ltd., of Sydney, Australia.

Grants and Awards

Five Bausch and Lomb Science Scholarships, valued at $1,500 each, have been awarded at the University of Rochester. Seven other finalists in the nationwide competition stood so high that they have been awarded comparable scholarships by the university. A total of 61 students, including this year's recipients, have been granted major scholarships at the university as a result of the annual Bausch and Lomb Science Scholarship contests during the last six years. The awards are made on a competitive basis to students throughout the United States.

The Commonwealth Fund has awarded 20 fellowships for 1949–50, among them 12 to the following scientists: *Richard E. D. Bishop,* assistant lecturer in applied mechanics, South East London Technical College, to study mechanical engineering (dynamics and vibrations) at Stanford University; *John Glover,* assistant lecturer in biochemistry, Liverpool, to study the techniques of radioactive and stable isotopes as tracer elements for the investigation of biochemical processes, at the Edward Mallinckrodt Institute of Radiology, St. Louis; *A. Michael Michelson,* research student, Cambridge, to study the broader aspects of nucleic acids and nucleotides at the California Institute of Technology; *John C. S. Paterson,* senior registrar, Department of Medicine, Post-Graduate Medical School of London, to study the chemical pathology of extracellular fluid in the presence of anemia, at the School of Medicine and Dentistry, University of Rochester; *Audrey Jane Pinsent,* research student, Lister Institute, University of London, to study the functions of trace elements in the metabolism of microorganisms, at Stanford University's Hopkins Marine Station, Pacific Grove, California; *William I. Pumphrey,* research leader, Department of Industrial Metallurgy, University of Birmingham, to study the application of metallurgical principles to industry; *Claude A. Rogers,* assistant lecturer in mathematics, University College, London, to study the geometry of numbers and combinational topology at the Institute for Advanced Study, Princeton; *George J. Romanes*, lecturer, Department of Anatomy, University of Edinburgh, to study the structure of the nervous system, especially the ventral horn cells, at the College of Physicians and Surgeons, Columbia University; *George Smith*, extradispensary surgeon, Western Infirmary, and demonstrator in anatomy, University of Glasgow, to study cardiovascular surgery and congenital disorders at the Johns Hopkins Hospital, and at the College of Physicians and Surgeons, Columbia University; *Len C. Taylor*, research student at the Oxford Institute of Experimental Psychology and the Department of Education, Oxford University, to study adolescent educational psychology; *Darcy Walker*, research fellow, Physics Department, University of Birmingham, to study experimental techniques in nuclear physics at Cornell University; and *Peter J. Wheatley*, demonstrator and lecturer in chemistry, University of Oxford, to study the infrared spectra of rapidly burning substances, at the University of Minnesota.

The National Foundation for Infantile Paralysis has allocated almost $2,000,000 of March of Dimes funds for new projects in virus research, professional education and training in poliomyelitis, and study of after-care of the disease.

The grants for virus research were made to New York University-Bellevue Medical Center, University of Minnesota, Michigan Department of Health Laboratories, University of Michigan, Bowman Gray School of Medicine of Wake Forest College, University of Washington, University of California at Berkeley, University of Pittsburgh, Johns Hopkins University, Yale University, Chicago Board of Health, University of Tennessee, and University of Cincinnati. National Foundation headquarters will administer an appropriation of $20,000 to determine the role of flies in the transmission of human polio.

Recipients of appropriations for professional education are American Public Health Association, National Organization of Public Health Nursing, American Physical Therapy Association, Committee on Careers in Nursing, D. T. Watson School of Physical Therapy, Northwestern University Medical School, University of Southern California, Meharry Medical College, and Washington University School of Medicine.

Eight medical schools and hospitals received funds for the study of after-care. They are Children's Hospital, Boston; University of Illinois; Northwestern University; University of California; University of Minnesota; Brown University; University of Vermont; and Cornell University.

Fellowships

The National Research Council announces the availability of a fund of $25,000 from the estate of Charles R. Blakely for support of research in the field of lymphatic leukemia. Application forms for grants-in-aid from this fund and further information may be obtained from the chairman, Division of Medical Sciences, NRC, 2101 Constitution Avenue, N.W., Washington 25, D. C.

The American Cyanamid Company announces the renewal of 15 scholarships for the academic year 1949–50, chiefly in the fields of chemistry and chemical engineering. These scholarships provide $1,500, and are awarded to graduate students in their last year of predoctoral study. Recipients of postdoctoral scholarships receive $3,000.

Scholarships have been established at Brown University, Massachusetts Institute of Technology, Columbia University, Princeton University, University of Virginia, Pennsylvania State College, Cornell University, University of Illinois, University of Notre Dame, University of Michigan, University of Wisconsin, University of Minnesota, University of Colorado, and Purdue University.

The National Foundation for Infantile Paralysis announces the following scholarships and fellowships available in physical medicine, public health, medical social work, and physical therapy, under recently approved appropriations totaling $495,000: $100,000 has been allocated for clinical fellowships in physical medicine for periods of one to three years of study, open to physicians who wish to prepare for eligibility for certification by the American Board of Physical Medicine; $50,000 for fellowships to physicians for one year of postgraduate study leading to the degree of Master of Public Health; $225,000 for physical therapy scholarships in approved schools for men and women in need of financial aid to complete training; $100,000 for medical social work scholarships; $20,000 for fellowships of two to four weeks' duration for the study of poliomyelitis patients at courses to be given at Children's Hospital in Boston, City Hospital in Cleveland, University of Colorado Medical Center in Denver, and Stanford University School of Medicine in San Francisco. All scholarships are on a competitive basis. Further information and application blanks may be obtained from the Division of Professional Education, National Foundation for Infantile Paralysis, 120 Broadway, New York 5, New York.

Colleges and Universities

The Medical College of the University of Vermont has established a Cardiovascular Unit in its Bishop DeGoesbriand Hospital. W. Raab, professor of experimental medicine at the university, will be director and attending physician. Dr. Raab, a former assistant of K. F. Wenckeback, cardiologist at the University of Vienna, has been conducting cardiovascular research at Burlington since 1939.

The Midwest Inter-Library Center, incorporated last March under the auspices of ten Middle Western universities, will be located on the University of Chicago campus. The center, a nonprofit corporation, was established with a $750,000 grant from the Carnegie Corporation and a $250,000 grant from the Rockefeller Corporation. It is a libraries' library and will furnish central housing and servicing for cooperative deposit and use of research materials by the participating universities which are: University of Chicago, University of Illinois, Illinois Institute of Technology, Indiana University, State University of Iowa, University of Kansas, Michigan State College, University of Minnesota, Northwestern University, and Purdue University. More than a million volumes will be stored in the six-story building. The site provides sufficient space for a second unit to be built in the future.

Industrial Laboratories

New laboratory facilities for chemical and physical research by the **Kellex Corporation** for the U. S. Atomic Energy Commission in its nuclear reactor development program are now in operation at the Jersey City plant of the M. W. Kellogg Company, the parent company. The laboratory will be headed by W. A. Bain, director of chemical research.

Adenosine-5-phosphoric acid (AMP), the adenine nucleotide usually called muscle adenylic acid, is now available from **Schwarz Laboratories, Inc.** Made by a process that does not require the use of animal tissues, this basic constituent of such vital coenzymes as ATP and coenzyme I has been used clinically in the treatment of cardiac affections, some types of rheumatic conditions, and malnutrition.

Meetings and Elections

Plant and animal nutrition in relation to soil and climatic factors will be the theme of the first of the series of British Commonwealth specialist conferences on agriculture, recommended by the 1946 Official Scientific Conference in London. The conference will be held in Australia in August. Visitors from the U. S., Canada, India, South Africa, and New Zealand will participate.

A colloquium on macromolecules will be conducted on September 2, 3, and 5 by the Macromolecules Section of the International Union of Chemistry, as part of its September 5–11 conference. Subjects under discussion will include the kinematics of polymerization and macromolecules in solution. The colloquium was initiated by H. F. Mark, of the Polytechnic Institute of Brooklyn, and has as its executive committee H. R. Kruyt, chairman; J. J. Hermans, R. Houwink, C. Koningsberger, L. J. Oosterhoff, J. Th. G. Overbeek, and A. J. Staverman, all of the Netherlands. Further information may be obtained by writing to the Executive Committee, P. O. Box 71, Leiden, Holland.

Plans are being made for the **Fifth International Congress of Microbiology** to be held August 17–24, 1950, in Rio de Janeiro. The executive committee includes Henrique Aragao, president; H. C. de Souza-Araujo, first vice president, Genesio Pacheco, second vice president; Olympio da Fonseca, executive secretary; Joaquim Travassos, secretary; Cassio Miranda, treasurer.

The program is built around sections on general and industrial microbiology, medical bacteriology, viruses, Rickettsial diseases, mycology, protozoology, bacterial diseases of plants, microbiology of water and soil, and immunity and resistance.

President Dutra of Brazil has authorized a special round-trip Brazilian boat for the transportation of European members and delegates to the congress, and hotel accommodations will be arranged for them by the committee.

The National Shellfisheries Association, at its annual meeting June 7–9, elected the following officers: president, James Nelson Gowanloch, Louisiana Department of Wildlife and Fisheries; vice president, James B. Engle, U. S. Fish and Wildlife Service; secretary, A. F. Chestnut, University of North Carolina Institute of Fisheries Research; and treasurer, David H. Wallace, Maryland Department of Tidewater Fisheries. The meeting was held jointly with the Oyster Institute of North America and the Oyster Growers and Dealers Association of North America.

An international conference on the optical properties of thin films was held in Marseille, April 19–23. This was one of a series of scientific gatherings sponsored by the French Centre National de Recherche Scientifique. Among the representatives were A. Vasicek from Czechoslovakia; P. Jacquinot, M. Perrot, and P. Rouard from France; K. Greenland, O. S. Heavens, H. Kuhn, and S. Tolansky from England; P. Van Alphen and B. Blaisse from Holland; M. Ballerini from Italy; M. Schaetti from Switzerland; B. Billings, J. Strong, N. Scott, and A. Turner from the United States. The conference was organized by P. Rouard, director of the Physical Laboratory of the Faculté des Sciences in Marseille.

This conference was a manifestation of the current interests in thin film optics. These interests were kindled by the evaporation of metallic reflecting coats by Ritchl and Ornstein, by low index reflection-reducing and high index reflection-enhancing films, and by combinations of all these to produce color films, filters, and interferometers.

The conference itself was outstanding in that each paper presented material completely different from the others. This was particularly remarkable since the publications of several of the members were in journals not accessible to the others. The conference was divided into several sections. The first was devoted to the discussion of the theoretical analysis of the optical behavior of thin films. Several ingenious techniques were presented for the mathematical treatment of films of varying index of refraction. One treatment was based on the electrical impedance analogue, another used a matrix technique in which the equations were set up for many layers, which were then allowed to become infinitesimal in thickness. These treatments would seem to foreshadow the more frequent appearance of such films in the laboratories of experimental physicists.

In the next section most of the papers were on the optical properties of thin films. Two pieces of research reported were new to most of the American group. One was the demonstration by Professor Rouard of Marseille which showed that the reflection of light going from glass to air can be eliminated by a metal film. In this demonstration light was reflected from a wedge of glass which was coated on the back by a wedge of metal. The metal surface was imaged on the screen and showed a black band at the thickness at which reflection was eliminated. Because of dispersion in certain metals the black band was replaced by a colored fringe. Another piece of new research was the preparation of a film of iron oxide which seemed to combine the mechanical features of TiO_2 film with the desirable optical features of Sb_2S_3. In this same group of papers were a series of talks on narrow band filters. One five-layer filter had both narrower pass bands and higher peak transmission than the older type of silver-dielectric-silver interference filter.

The final part of the conference was given over to the applications of thin films. Although the optical properties of thin films may be a narrow field, this last section showed clearly that it is important in many branches of science. Discussions ranged from the aluminizing of large telescope mirrors to use of interferometers in series for the detection of faint satellites in spectra.

In this section we were especially excited by Professor Tolansky's provocative experiences with interference plates using "Fabry-Perot" reflectivities with "Newton's" spacings. Using his procedures, distances to 10 A or less can be measured. Many unsettled questions were posed by him—for example, he reported unexplained jagged fringes when a thin curved piece of mica is interposed between his plates.

The hosts of the conference organized excursions and diversions which adroitly combined the abundant history and scenery with the scientific activity which is available around Marseille, to produce a lasting impression in the memories of the conferees. All conferees, after a few hours, were fraternizing as if they had been collaborators in the same laboratory.

JOHN STRONG and BRUCE BILLINGS

Deaths

Earle L. Overholser, 60, head of the Department of Horticulture at Virginia Polytechnic Institute, died on April 18. Dr. Overholser was an authority on tree fruits.

Francisco Sierra Soto, Colombian plant scientist trained in the U. S., was assassinated June 19 near his farm on the lower Labrija River in the State of Antioquia. Dr. Soto was engaged in a research and development project conducted cooperatively by the U. S. and Colombia to encourage modern rubber plantations in Colombia.

Ivan L. Nixon, 65, vice president in charge of the Scientific Instrument Division of Bausch and Lomb Optical Company, died June 25. He was a member of the company's board of directors and a director of its Canadian company.

John C. Gifford, 79, professor of tropical forestry at the University of Miami, died June 25 at the Jackson Memorial Hospital in Miami. Dr. Gifford was founder and first editor of the *American Forestry Magazine*.

Harry Manley Goodwin, 79, dean emeritus of the Massachusetts Institute of Technology Graduate School, died June 26 at his summer home at Squam Lake, New Hampshire. Dr. Goodwin's extensive research in physics and electrochemistry included electrochemical studies of the voltaic cell and the electrical properties of inorganic salts at high temperatures.

After a lapse of five years, owing to the war, the **Theobald Smith Award in Medical Sciences**, established in 1936 by Eli Lilly and Company, will again be given at the Annual Meeting of the AAAS. Fellows of the Association should submit names of proposed recipients to Dr. Gordon K. Moe, secretary of Section N, Medical School, University of Michigan, with full information (in triplicate) concerning personality, training, and research work of candidates. Nominations must be received *before September 15.* The award will be $1,000 and a bronze medal, given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." An additional amount of $150 is available toward traveling expenses. The recipient must be less than 35 years of age on January 1 of the year in which the award is to be made, and a citizen of the United States.

Past recipients are Robley D. Evans, professor of physics, Massachusetts Institute of Technology, Cambridge; Charles F. Code, Department of Astronomy and Astrophysics, Yerkes Observatory, Williams Bay, Wisconsin; Albert B. Sabin, professor of pediatrics, Children's Hospital Research Foundation, Cincinnati, Ohio; Herald R. Cox, director of virus research, Lederle Laboratories, Inc., Pearl River, New York; and Sidney C. Madden, professor and head of Department of Pathology, Emory University School of Medicine, Atlanta.

The Alabama Science Talent Search for General Gorgas Scholarships, conducted by the Alabama Academy of Science in cooperation with Science Service, has awarded scholarships at the University of Alabama, Tuskegee Institute, Alabama Polytechnic Institute, Birmingham-Southern College, and Howard College. Winners receive four years' tuition and fees from the various colleges and cash awards ranging from $500 to $1,500, given by the Alabama State Chamber of Commerce, in cooperation with business and industry.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has submitted the following list of wanted chemicals: Muscone, 1,1-diacetylethylene, colophene, vicine, isoascorbic palmitate, phosphonium chloride, perfluoroheptane, trans-hexahydrophthalic acid, β-tocopherol, isatoic anhydride, isocitric acid, isoaconitic acid, 2-hydroxybenzothiazole, 2-nitrosophenol, adenine thiomethylpentoside, 2,2-difluoroheptane, uric acid riboside, ketosuccinic acid, keracyanin, and muscarine.

The Agricultural Impasse

W. Gordon Whaley, *Director*

The Plant Research Institute, The University of Texas

THE EFFORTS OF ALL PEOPLES to achieve a place in the sun have turned around the land and what it produces. Among the underlying causes of war, no factor is of importance nearly equal to that of the relation of a population to the productiveness of its lands. This relation involves a complex equation between the utilization of ores, molecules, and atoms and the handling of plants and animals which supply the energy for living. No course can more surely invite disaster than one which fosters headlong improvement in peace and war of industries which consume the products of the land while it all but ignores our relatively poor success in handling the land and its living cover.

The source of man's energy is the green plant. Maintenance of his energy supply or its increase depends upon apt handling of his plants. If he fears the cutting off or liquidation of this supply he will fight for its preservation. The adequacy of the supply and its distribution is, in the last analysis, the key problem. Today we have an alternative to the age-old unbalance of the fat years and the lean, the haves and the have-nots, and the birth of countless millions of human beings to the misery of inadequate food—we can replace "farming" with agriculture, the science of handling the land and its plants and animals.

Great progress in such a revolution has already been made. American agriculture, quite as much as American industry, helped to turn the recent tide of war toward the victory. Many of the peoples of ravaged Europe and Asia owe both their freedom and their postwar survival to the American farmer. But we are moving too slowly. The pressure of war and postwar conditions has so increased the drain of soil fertility and the effects of erosion and inefficient culture that these and related factors are reaching an emergency status earlier than they would have, had a normal peacetime pace prevailed. In much of our supporting agricultural research, too, we have reached an impasse; and in this there is great danger, for the laws of energy will not indefinitely permit increase of demand, without parallel increase in the available supply.

From any long range view, further lifting of the world standard of living can only follow increases in agricultural efficiency. In fact, because of increasing population pressures, even maintenance of the present standard demands a very considerable increase in this efficiency. The Food and Agriculture Organization of the United Nations estimates increases (over previous production) of 21 percent for cereals, 100 percent for milk, and 163 percent for fruits and vegetables as minimum requirements for feeding the expanding world population by 1960. The land available for growing these increased crops has shrunk from deterioration and misuse. Moreover, the hope, often expressed, that such increases can be produced in tropical countries overlooks the severe limitations of these regions. In most tropical regions there is, so far as agriculture is concerned, relatively little usable land. There are no great prairies, and because of the topography only limited areas can be turned to the production of energy crops. Continued high temperatures and excessive rainfall restrict both the types of plants that will grow and man's efforts to grow them. Such conditions also often increase the magnitude of disease and insect problems to nearly uncontrollable proportions. The production of the tropics is destined to be of growing importance with respect to many crops, but the resources of the tropics are simply not such as to make the regions capable of assuming a major position in the production of the energy crops. We must look instead for means of greatly increasing the production of Temperate Zone farms.

THE BASIC PROBLEM

In emphasizing the need for conservation, it is common to picture the land as a potential resource, a sort of agricultural safe deposit box from which man may draw fertility for his crops for an indefinite period. If he withdraws this fertility too rapidly, however, or allows the mineral elements to be washed away by erosion, he must move on to new land or, when new lands are no longer available, face ruin. All this is true, but it is a concept too limiting to serve as the basis of a scientific agriculture. It is necessary, instead, to think of a farm as a factory and the farmer's managing efforts as attempts to turn raw materials into fine goods, soil elements into plant products. The goal is the most rapid practical turnover of fertility, the highest production consistent with continual availability of raw materials. Many of our soils lack certain essential elements, but most of them contain, in practically inexhaustible amounts, all the required elements except nitrogen, phosphorus, and potassium. Agriculture becomes then in part a matter of supplying phosphorus and potassium as crude chemicals in the right amounts, fixing nitrogen chemically or by the activity of microorganisms, and providing in one way or another such additional elements as may be required to enable the protoplasm of the living plants to manufacture, in mass production, fine goods.

This is the salient fact. In practice the operation is exceedingly complex, and we are in discouraging ignorance of most of its components. The soil in which many key processes go on is a variable and little understood medium, the steps in the functional processes by which plants convert materials from soil and air and the energy of light into fine goods are nearly complete mysteries, and the intricate balances of soil, plants, and climate have hardly been approached. We know only enough to realize how much needs to be learned and to recognize that if we had more knowledge we could make much better adaptions, maintain much better balances, and control the hazards more effectively.

Effective long range use of the soil with efficient cultural practices and adequate control of diseases and insect pests are pressing agricultural problems, but there are others. True to the American pattern, we have made greatest advances where mechanization fits into agriculture. In many crops all operations from sowing to harvesting are now carried out by machines. One effect has been to call for greater efforts to improve plants; for the more highly developed agricultural practices become, the more urgent is the need to produce more efficient plants—plants which can produce more fine goods per unit of raw material, or which, better fitting the pattern of mechanized farming, can produce more cheaply.

Advances in soil practices, control of plant diseases and pests, mechanization of farming operations, and plant improvement already have been great, but not so great as not to be dangerously dwarfed by industrial advances and the factors of population increase of the past several decades. Thus, an unhealthy situation arises. The more the efficiency of industry is increased and the higher wages it can pay, the more difficult it becomes for the less efficient agriculture to find labor and capital. The more efficient industry becomes, the more it expands and the greater becomes the need for new or better agricultural products; and even apart from industrial development, the more population increases the more people agriculture has to feed and clothe.

In any analysis of American agriculture's besetting difficulties a single fact stands out above all—the need for a coordinated and effective program of research.

Agriculture is still, by and large, in the hands of individual farmers with access to relatively little capital as compared with large industrial corporations. Even in good times, individuals are rarely capable of supporting research and experimental development. Then too, the farmer's immediate problems are generally tied to a particular piece of soil in a specific climate, and to the caprices of the weather. It is difficult for him to think in the broader terms which characterize modern basic industrial research.

What is termed industrial research really represents two usually more or less distinct elements. The general fact finding is perhaps accomplished most often by investigators outside the industrial laboratories, by the workers in "pure" sciences, most often in university laboratories. Industry carefully currycombs the findings of such investigators and then tests any interesting facts revealed. Agriculture has no adequate provision for either part of this operation.

The fundamental unit in agricultural research is a living plant or animal and its products. This fact gives a distinguishing breadth to agricultural research needs. Plants and animals are all composed of a common stuff and they all grow according to similar patterns. As a result, research on corn may prove to be just as important for the cotton farmer as for the corn farmer. This means that one has to think in specific terms of cotton or corn and at the same time in general terms of living organisms. The biologist investigating a specific problem in corn soon finds himself knocking at the closed door of what life and growth and sensitivity are. His field is far more mysterious, and, one suspects, far more difficult than those of his colleagues working with inanimate atoms.

The peculiar status of agricultural research needs has been recognized for some time. It was in response to this recognition that the plant and animal research branches of the United States Department of Agriculture and of the various state experiment stations were organized. We have in the correlated branches of these agencies a structure which is theoretically capable of dealing with both short range research, concerned with solution of the farmer's immediate problems, and long range research on fundamental problems. In actual practice, it does a good job at the former and shies away from the latter. The American taxpayer is putting millions of dollars annually into agricultural research. He is getting progressively smaller returns, and too few of these are the kind that will pay off in the long run. Why?

FEDERAL AND STATE PLANT RESEARCH

So far as the national picture is concerned, crop plant research is centered in the Bureau of Plant Industry, Soils and Agricultural Engineering of the

United States Department of Agriculture. This agency is composed of several hundred professional plant scientists, operating on a budget which, counting both direct and indirect appropriations, approximates ten million dollars a year. Its staff probably contains between one-quarter and one-third of the country's plant scientists, the remainder being distributed fairly equally among other federal agencies, the state experiment stations, and the colleges and universities.

Agricultural research is almost necessarily a ward of the state, and this federal bureau should be the dominant agency in plant research—stimulating fundamental research by its own research productiveness, on one hand, and guiding the application of newly discovered principles on the other. Actually, its accomplishments in the first field are considerably less than they might be, though at one time the Bureau played a much more important role than it now does.

Some of its deficiencies are fairly easy to indicate. Its staff is made up of a very considerable number of topflight scientists, but it also has more than a few mediocre persons who value the security of federal civil service retirement more highly than real scientific accomplishment. Unfortunately, the system is such that the potentialities of many of the best men are not realized. Too often the civil service system and good productive research don't mix. This is a serious business, for it has driven many of the best of the wartime federal scientists out of the government service into industrial or university work, and usually away from pressing problems concerning the national welfare. Many factors are involved. One is bureaucratic insistence upon establishing organizational patterns without appreciation of the need for flexibility in research. Another is the too frequent reservation of higher grades for administrative employees. The effect of this is to make administrators out of the more capable men, and conversely to keep actual research activities in the hands of the less capable, or less advanced. Productive research is a coupling of ideas with experimental techniques. Only in rare instances can each component come from individuals at different levels of responsibility, separated perhaps by thousands of miles. Seniority, so necessary to maintenance of a good organization, often precludes obtaining the best qualified investigators for particular problems. The civil service efficiency rating system, though it is handled in general with attempts at the utmost honesty, often complicates the picture, for the employee's advancement chances turn directly upon it. It is probably possible to make estimates of the comparative efficiency of twenty-five typists working in the same office. In fields of scientific endeavor, however, such comparative ratings are literally impossible. You simply cannot measure a man's scientific productiveness in terms of his industry, his ability to get along with his superiors, the degree of neatness with which he conducts his work, and so on. What you have to evaluate is his brain power. What the civil service system evaluates is his capacity to fit comfortably into an organized pattern. The organization is the thing. If a man fits it—well, let's not worry too much about the fact that he likely is not the most brilliant man in his field. Some signs are appearing which seem to indicate fettered steps on the part of the Civil Service Commission to attempt some modifications of its system to deal with the needs of research agencies. This could be hailed as progress were it not that the organizational difficulties of the agricultural research bureaus would likely be self-perpetuating even without civil service.

But the personnel difficulties are not the only important ones. The present plant scientists of the federal system could turn out far more productive research if they were not hampered by the nature of the system itself. Let's examine the system.

A group of working-level scientists conceive a research project which they feel, on the basis of their specialized training and experience, may reasonably be expected to answer some questions which are bothering them in their attempts to improve a certain crop plant. They draw up an action plan, with all the necessary attention to organizational detail. The plan is reviewed by their division head and the chief of bureau, with his assistants acting as advisors. If approved by these men, it is sent on for approval by the Agricultural Research Administration. This is a superstructure agency whose functions include overseeing the work of all the Department of Agriculture research units and their cooperative work with state agricultural groups.

The concept behind the organization of the Agricultural Research Administration was that it should coordinate the efforts of different groups, eliminating unnecessary duplication, and in general tie together the work of federal and state agricultural scientists, and guide their research along profitable lines. It was a noble concept. With vision and a degree of freedom, the Agricultural Research Administration could lead all the country's agricultural research, stimulate important allied researches, and very effectively raise agricultural efficiency, not only in this country but over the world. It could be one of the greatest factors in our world leadership, for little we could do would be of greater benefit to mankind. Actually, the task of the Agricultural Research Administration is, at least in part, one of dignified pussyfooting. To it falls the responsibility for sorting out of the federal agricultural research proposals those which Congress will approve and shunting the others to the side lines. It is the liaison agency attempting to maintain long term productive research against the backdrop of Congressional political interests. It must see that only projects likely to have enough Congressional support or public interest are presented for consideration, for the support for the research comes, with a few minor exceptions, from the public treasury. The funds are authorized by Congress on an annual appropriation basis. These appropriations, woefully inadequate if judged against the magnitude of the problem, are relatively small items in the great Department of Agriculture Appropriations Act, which provides for the many important and unimportant services of the department.

Here is a major difficulty, for the basic problems of plant improvement are hardly likely to be intriguing to either Congress or the general public. The Agricultural Research Administration attempts to be certain that the scientists never use language which would sound as though they were talking down to the legislators. Hence its scientists, to start a research program, must sloganize it, must optimistically forecast great results from it, and report its progress in journalese. In short, prosaic scientific research, whose interpretation requires the precision of its own scientific terminology, must be dramatized—and in words of one syllable. The Agricultural Research Administration cannot permit an attack on problems that Congress might feel are too remote. Then there are issues to be attended to like the demands of the state agencies for research assistance. With such responsibilities the Agricultural Research Administration has little time for anything like deep-delving consideration of basic agricultural research needs. If the research structure is to survive with Congressional support, it must occupy itself with the questions of the moment. There is no time to worry about the farmer's grandchild.

Congressional interest in research projects introduces other trouble, too, such as making it much easier to go on spending money on something established than to institute anything new. Hence, the scientists have to try to extend already established researches and bend them around new needs, often getting only half as far as they should. And they sometimes continue researches that might have been stopped years ago at no great loss. This situation is particularly true where experiment stations have been set up. The presence of these stations, some of them very small, becomes important in the congressman's constituency. The Department of Agriculture budget supports several such stations which offer little but vain hope of ever serving any purpose that cannot be served more effectively elsewhere. Once in a while Congress gets too excited, or its prodders do, about some question involving agricultural research. When this happens, the scientists have to occupy themselves for a year or two with attempts to spend short term money effectively. Then Congressional interest in that particular problem wanes. The men in the research organization are left with nothing but the knowledge that a few thousand dollars a year for ten years and freedom to attack basic problems would probably have solved the difficulty. That the final determining review of research basic to the country's agricultural future should be in the hands of Congress is logical only if Congress seeks and is guided by the advice of the best specialists in the field. The record doesn't suggest that Congress operates in this way. Even if it did, the system would remain inadequate until the major part of the research could be relieved of the compulsive uncertainty that it reflects from the single-year appropriation scheme.

The federal plant scientists have another big handicap. Like the rest of the government machine of these United States, the Department of Agriculture is a bureaucracy—too large a portion of its staff has to be concerned with the functioning of the machine. And the scientist has to spend too much of his time making reports, reports, and reports on his organization for research. The research he cannot find time to do. A man who is good enough to get along soon finds himself occupied most of the time with reports on and justification of the efforts of those behind him in the line of ascent.

The agricultural research efforts of the states are conducted by the state experiment stations, which are affiliated with the land grant colleges. These agencies have many of the same difficulties as the federal system. They are too often staffed with people of insufficient breadth—partly because for many years most of the state experiment stations could pay only very low salaries, partly because the state scientists are under pressure by local legislatures and populations to direct all their attention to matters of immediate concern in the locality. The logical field of effort for such experiment stations concerns problems that are more or less local, having to do with the particular crops of a given state and their behavior and management under the environmental conditions in that state. It is generally considered poor economy for the state experiment station to allow its staff members to devote time to problems not immediately related to the needs of the state's farms.

THE EVOLUTION OF THE PROBLEM

Many state research scientists and federal scientists share one characteristic that is somewhat less readily recognized than those we have been discussing, but that is perhaps the most important in an over-all consideration. This is their failure to foresee what might be called the evolution of agricultural problems and to prepare themselves to deal with the products of this evolution. When the great agricultural agencies of the nation were organized, the compelling problems, for the most part, had to do with handling crops in the field—determining the proper soil for a given crop, the best time of planting, the most productive spacing, and the most effective fertilizers. With the development of agricultural engineering, there were the added problems of building machines for planting, cultivating, and harvesting different kinds of crops under different growing conditions, and developing methods for the control of insect and disease enemies. The agricultural agencies were founded for attacks on such problems as these. The present status of American agriculture is a tremendous tribute to the achievements of the agricultural research scientists in meeting these problems and solving them effectively. Much remains to be done, but what is not clearly enough recognized is that by solving these problems so effectively these same scientists have opened up new frontiers of research, have pushed the research needs along to another stage.

We are now at a point where major agricultural advances can come only after we have gained much more knowledge concerning the fundamental biology of our crop plants. Improvement in field practices may be expected to give perhaps another ten percent in increased yields. It will result in saving some land and it will bring further lightening of the farmer's labors. This sort of progress must be continued, but major advances will come only if we supplement such investigations with enough basic biological research to enable us to begin to learn something more than superficial facts about how plants grow, how they reproduce, and what their relations to soil and climate are. The agencies which have been built up under civil service regulations are staffed almost entirely with the researchers to whom goes the great honor of having solved the first line problems. However, it follows from the very nature of these investigators' training and interests that they generally do not recognize or have an interest in the now basic biological problems. Hence, the agricultural research agencies are tending to neglect seriously the biological problems which are at the base of the next century's improvement in agriculture or even the next century's continuation of agriculture at its present highly productive level. They are neglecting these problems sometimes for lack of time to deal with them, often on the assumption that the colleges and universities will produce a generation of men better prepared to deal with them.

This last point needs examination in the light of the facts. The avowed purpose of most agricultural colleges is to train agriculturists. To this end their faculties are organized and their curricula developed; and to this end they are generally most successful. There is, however, much confusion between the requirements of agriculture and the requirements of agricultural research. Young men going through agricultural curricula are encouraged to stay on and work toward advanced degrees, and then to accept positions of responsibility in agricultural research. If they are to deal with the kind of problems which were the predominant ones in agricultural research during the last half century, they are generally adequately prepared. We shall need many more of them. But we also need a different type of investigator, a member of a group in step with the newer problems in the second line of research, with the fundamental biological and biochemical problems. It is a mistake to assume that a man trained in agriculture is qualified for this type of specialized agricultural research.

If the agricultural colleges must continue to devote their efforts mostly to the training of agriculturists, then where are the people capable of solving the more complex fundamental biological problems to come from? One might expect that colleges and universities which are less directly connected with agriculture should be in a position to train such people. Though they may be in such a position, too often they are not interested. Their botanists and zoologists tend, more or less purposely, to concentrate their efforts on investigations which have no bearing upon practical problems. Their chemists and physicists are busy responding to the demands of industry, which recognized long ago the need for continuing to harvest annual crops of fundamental researchers.

It behooves these colleges and universities to examine the thesis which guides their training of young men and women for productive lives. It behooves these institutions and the agricultural colleges to look further into the basic training requirements for agricultural research. It behooves a lot of professors to examine the relative worth of the problems with which they occupy themselves and a lot of practical-minded agriculturists to look far enough into the ivory towers to see whether anything in the way of useful knowledge may be written on the walls. Yale University and the University of Connecticut have recently established what may become a pattern for the training of agricultural research scientists. In a cooperative scheme, students are given two or three years' work in the fundamental biological sciences and directly allied fields at Yale and then they go to the University of Connecticut for a year or more to study application of the facts and techniques of these fundamental sciences to the problems of agriculture. Although it would not seem adaptable under most circumstances, this scheme recognizes the key to the problem. Agricultural research in the commonly accepted sense is not enough. It must be expanded to include far more biological research. In the case of plants and their products, we must direct major rather than incidental efforts toward unraveling the facts of growth, development, and reproduction, and the interrelations of these with soil and climate. When enough such background has been accumulated, then agriculture's practical problems must be reviewed against it.

To gain this critical knowledge we need to make certain changes. Our federal research agencies must be relieved of the requirement to concentrate their efforts on sure-fire, immediately solvable problems, while their scientists defend Congressional mandates for fundamental research. They must expand their research to determine how the green plant combines carbon dioxide and water to produce carbohydrate and then transforms the carbohydrate to thousands of useful substances, and to attack a selected group of other fundamental problems. This calls for a revision of the setup, a new deal from civil service, new types of Congressional authorization and support—all matters of federal government concern. But it calls for other things, too. There must be leaders who can lead, men who can appraise trends in all the sciences and interpret their significance for agriculture, who can recognize the gaps that stop progress, and furnish the individual scientists with charts for action. Such men are likely to come only after a renaissance in teaching and training has directed students in basic biology, chemistry, and physics toward agricultural problems. This calls for reorientation by the colleges and universities with direct or indirect interest in the field, closer cooperation between pure and applied science groups, and the development of programs which will train much more highly and educate more broadly at the same time.

The Significance of Meiosis in *Allomyces*

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TWENTY YEARS AGO Hans Kniep (*7*) described in the water mold *Allomyces* a life cycle and a type of sexuality which were previously unknown in the fungi. The cycle, which now serves to distinguish the subgenus *Euallomyces* (*3*), is outlined in Fig. 1. Sexual reproduction is accomplished by fusion of a small, motile, pigmented male gamete with a somewhat larger, motile, unpigmented female gamete. A year later, having discovered that the nuclei in sporophytic hyphae had about twice the volume of those in gametophytic hyphae, Kniep (*8*), postulated that meiosis occurs in the resistant sporangia of *Euallomyces* and that there is an alternation of haploid gametophytes and isomorphic, diploid sporophytes. Similar studies subsequently led Sörgel (*12, 13*) to accept this concept, and Emerson (*3*) presented genetic evidence, obtained from interspecific crosses, which gave strong indirect support for Kniep's interpretation of the life cycle. Although Hatch (*4*) had made a detailed cytological study of dividing nuclei in zygotes of *Euallomyces* and concluded that meiosis occurred at zygote germination, he later (*5, 6*) denied the validity of his own interpretations and accepted Kniep's hypothesis.

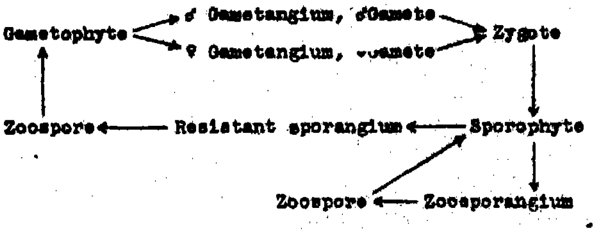

Fig. 1. Life cycle of Euallomyces.

Kniep himself was quick to recognize the unusual possibilities which *Allomyces* presents for experimental investigations of sexuality and reproductive behavior, and subsequent studies by others amply testify to the keenness of his insight. A variety of basic researches using this phycomycete to investigate phenomena of apomixis, sex determination, irradiation action, nutrition, metabolism, and the physiology of spore-maturation, -dormancy, and -germination are under way in a number of laboratories in the United States at the present time. Nearly all of this work is directly or indirectly related to chromosome behavior, and the urgent need for exact knowledge of the meiotic divisions has become increasingly apparent. By using the well-known aceto-orcein smear technique, the writers have recently succeeded in completing a critical cytological study of meiosis in *Allomyces*. It is the purpose of the present note, therefore, to give a brief report of the observations which have been made and to emphasize the bearing of these findings on the future use of *Allomyces* in various phases of biological research and teaching.

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[1] Guggenheim fellow at Harvard University.

Resistant sporangia formed by sporophytic thalli grown on slants of yeast-starch agar (*3*) ordinarily become capable of germination three to six weeks after their formation. At this time each sporangium contains about a dozen expanded, diploid nuclei in an advanced prophase stage. These sporangia are fully mature and, if air dried, they will remain viable and their nuclei will remain in prophase without any further detectable change for periods up to at least ten years. When mature resistant sporangia are taken directly from moist agar cultures and placed in water at 20° to 25° C, they form and release spores in 100 to 130 minutes. During this short interval the two meiotic nuclear divisions occur and are immediately followed by cleavage of the cytoplasm and organization of the zoospores. Each of these zoospores is haploid and normally uninucleate, and it has been determined that there are four times the number of zoospores per resistant sporangium as there were diploid nuclei at the start. Hence no haploid mitoses occur in the resistant sporangia. All of the nuclei in a given sporangium undergo meiosis almost simultaneously, and it has been possible to examine many preparations of each of the critical stages in both divisions. Careful analysis of metaphase and early anaphase figures of meiosis I has shown that the haploid chromosome number is probably 7 in *A. arbusculus* and 14 in *A. javanicus* var. *macrogynus*. Preliminary observations of meiosis in the F_1 resistant sporangia from crosses between these two species have revealed pairing of some of the 21 chromosomes and random distribution of the remainder.

The life cycle of *Allomyces cystogenus*, which is in the subgenus *Cystogenes* (*3*), differs strikingly from that of *Euallomyces*. As is shown in Fig. 2, there is no multicellular sexual plant, the zoospores from resistant sporangia becoming transformed directly into gametangial cysts, which release isogametes (*14*). Although various possibilities had been suggested, nothing was known about the place of meiosis in this cycle until it was discovered in the present study. Aceto-orcein smears of resistant sporangia of this species revealed a sequence of events exactly similar to those just described. There are two meiotic nuclear divisions which just precede spore formation. In the entire life cycle, therefore, there is but one mitotic division of haploid nuclei, and this occurs during gametogenesis in the cysts. The haploid chromosome number of *A. cystogenus* appears to be 7.

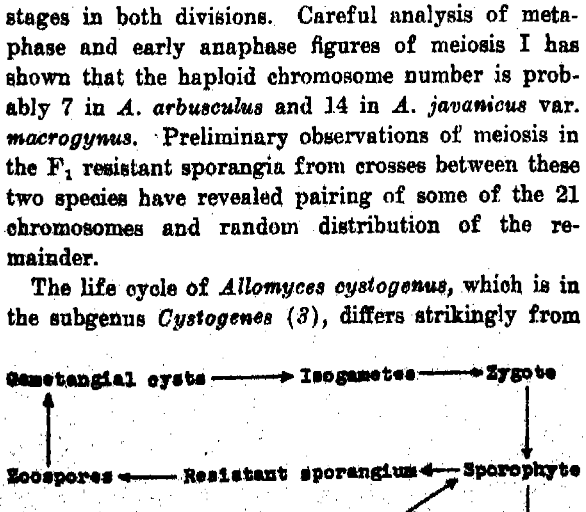

FIG. 2. Life cycle of *Cystogenes*.

The writers wish to focus attention on the relation of the foregoing observations to certain matters of general significance. First, it has been tacitly accepted for more than twenty years that meiosis in the common aquatic phycomycetes such as *Saprolegnia* occurs in the later stages of development of the fertilized egg, that is to say oospore. An examination of the literature, however, shows that virtually all of the evidence is negative, depending on studies which demonstrate that the nuclear divisions which precede gametogenesis are not meiotic. Indeed, although meiotic nuclei have been seen in several genera (*1, 2, 9, 10*), the present investigation appears to be the first critical step-by-step study of meiosis in an aquatic phycomycete. The successful application of the aceto-orcein technique to *Allomyces* indicates that renewed efforts to examine the meiotic processes of other phycomycetes should be revealing, despite the generally small size of the nuclei in these fungi.

Second, it should be understood that the conclusive demonstration of meiosis in the resistant sporangia of *Allomyces* places it, as Kniep (*8*) has already indicated, in the unique category of a filamentous fungus in which there are true diploid nuclei in the vegetative hyphae. The picture becomes even more striking when it is realized that mitoses are diploid throughout the entire cycle of *A. cystogenus*, with the exception of the single haploid division involved in gametogenesis. This nearly complete suppression of the haplophase is remarkably similar to that which occurs in some of the siphonaceous green algae. It is also interesting to note the close parallelism between present concepts of haploidy in the water molds and the situation which existed about twenty years ago, when Schussnig (*11*) and others were demonstrating the fallacy in the belief, generally held at that time, that all green algae are haplonts.

Third, it is obvious that knowledge of meiosis and specific chromosome numbers in *Allomyces* is going to facilitate greatly the planning and interpretation of genetic studies with this fungus. The feasibility of bringing large numbers of nuclei into meiosis at will on a definite time schedule will be of significance in future irradiation work. Self-fertility of the hermaphroditic sexual plants of *Euallomyces* makes possible in a single karyogamy the production of homozygosity in diploids, while normal dominance relations can be studied in heterozygous diploids.

Fourth, with 7 and 14 as basic haploid numbers, and with a considerable degree of interspecific compatibility, there is a very promising outlook for cytotaxonomic research, a field in which fungi have played little or no part hitherto.

Fifth, establishing the place of meiosis in *Euallomyces* has finally put this water mold in an exceptional position as a laboratory organism with which to demonstrate with diagrammatic simplicity each of the basic structures and processes involved in a generalized, sexual reproductive cycle. Sexual and asexual plants can be grown separately on ordinary laboratory media (*3*) and will produce their respective reproductive structures in profusion without special treatment. The release of gametes, haploid zoospores, or diploid zoospores can be induced at will in a given time simply by placing gametangia or sporangia in water. Arranged in terminal pairs, the male and female gametangia are distinguished by a striking color difference, the females being unpigmented, the males brightly colored with carotene. The difference in size and pigmentation of the gametes themselves makes it possible to identify them after their emergence, and the actual process of syngamy can be followed under the ordinary compound microscopes provided in an elementary laboratory. Surely few other organisms combine so fully and vividly those precise features required for an introduction to concepts and patterns of reproductive mechanisms in living things.

With its ready growth of either diploid or haploid phase in pure culture, its uninucleate motile gametes and zoospores, its colorfully differentiated gametangia, its hermaphroditism and self-fertility, its distinctive resistant sporangia which can so conveniently be used to perpetuate stock strains, and its uniform rapid response to transfer from nutrient agar to water, *Allomyces* is an organism with outstanding possibilities in the fields of biological research and teaching.

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AAAS Recommendation on Atomic Energy Act Amendments

The following memorandum, adopted by the AAAS Executive Committee at its meeting July 7, 1949, was sent to the McMahon Committee of the Senate:

The Executive Committee of the American Association for the Advancement of Science urges upon your Committee and the Congress the exercise of searching scrutiny and objective consideration of any amendments to or revisions of the Atomic Energy Act which would affect seriously if not disastrously the nation's progress in research. Such progress has resulted in the past less from great expenditures of money than from freedom of publication and of communication among scientists. Research has little potential value until its results are public property.

This Committee views with grave misgivings the proposal reported in the press that the export of radioisotopes for research by scientists in other countries be prohibited by statute, on the ground that such research might be applicable to military developments, and its publication might be detrimental to our national interest.

Any basic research has potential applicability to developments of all kinds, including military. This must be regarded as a small "calculated risk." The radioisotopes available to foreign scientists are of a kind not used in weapons, and their utility is preponderantly in tracer studies and medical research. The likelihood of their being employed detrimentally to our interests is practically nonexistent, whereas the potential benefits to mankind are great.

If there is hazard to us in the publication of results obtained abroad with radioisotopes, there is also hazard in publication of results of similar research done in this country with radioisotopes; and the same kind of logic would lead to prohibition of such publication here as of shipments abroad. Prohibition of publication would be highly detrimental to our interests, for research can thrive only in an atmosphere of free interchange among scientists. Without it there is no research. In view of the indisputable fact that research is essential to our leadership, it would be a serious matter indeed to prohibit export of radioisotopes (except those fissionable materials usable in weapons), as it would also to prohibit freedom of publication of results of research in this country, in which radioisotopes are used.

TECHNICAL PAPERS

Nitrogen Mustard Inactivation of the Cytoplasmic Factor Kappa, in *Paramecium aurelia*, Variety 4[1]

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The growing importance of chemical mutagens and their use in experimental genetics make a study of their effects on cytoplasmic factors desirable. The present work is concerned with the effects of the nitrogen mustard, methyl bis($\beta\beta'$-dichloroethyl)amine, on the cytoplasmic factor kappa, in *Paramecium aurelia*, variety 4, stock 51.

The first experiments were designed to test the effect of nitrogen mustard on killer animals growing normally at 27° C. In experiment 1, 2 ml of a freshly prepared buffered solution (phosphate, pH 6) of the hydrochloride salt of nitrogen mustard in a concentration of 0.19 mg/ml was added to a Columbia dish containing approximately 1000 killer animals in a small drop of culture fluid. Samples of up to 50 animals were washed and the animals were isolated individually and allowed to multiply for several days at maximum fission rate. At the end of this growth period, the cultures were tested for the presence of animals sensitive to the action of paramecin, the antibiotic which is produced by killer animals and which is responsible for their killing action. The method for the determination of the character of a culture is as follows. Samples of the culture in question are mixed separately with known killer animals and with known sensitive animals. If killing occurs in the mixture with killer animals, the culture contains sensitive animals. If killing occurs in the mixture with sensitive animals, the culture contains killer animals. If killing occurs in both mixtures, both sensitive and killer animals are present in the culture. In this case, the culture in question would show autolethality, i.e., the sensitive animals in the clone would be killed by the killer animals present. This method for testing the character of a culture was used throughout the study.

Experiment 2 was performed in the same manner as experiment 1. The exposing concentration was 0.434 mg/ml and different time intervals for exposure were used. Both experiments are summarized in Table 1.

It may be seen from this table that some of the killer animals were changed so that they gave rise to sensitive progeny. It will also be noted that, in general, the heavier the exposure to nitrogen mustard, the greater the proportion of clones containing sensitive animals and the greater the proportion of completely sensitive clones produced. Mortality also parallels the length of exposure. Killer animals not exposed to nitrogen mustard fail to produce sensitive progeny under similar conditions.

One interpretation of these data is that kappa has been inactivated in varying amounts with the different exposures. The production of sensitive animals, therefore, means that the number of kappa particles remaining in an animal is small enough to allow the animals to become sensitive to paramecin action (*2*). Animals which, at fission, receive at least one particle of kappa are able to give rise to clones which contain killer animals because kappa, when not affected by nitrogen mustard, can multiply more rapidly than the animals under the conditions of the experiments. Animals receiving no kappa are unable to initiate kappa formation and so remain sensitive (*2, 5, 6*). That this is the correct interpretation is shown by the experiments described here.

The expansion technique (Sonneborn, unpublished) allows the mean kappa particle number of the progeny of a killer animal to be reduced to any desired level. This technique involves growing the animals at 33.8° C, at which temperature the number of kappa particles fails to increase, and the animals undergo rapid fission, thus decreasing the number of kappa particles within the animals at each fission. The period of rapid fission at 33.8° C is followed by a period of slow fission rate at 27° C,

TABLE 1

EFFECT OF NITROGEN MUSTARD ON ANIMALS GROWN AT 27° C

Expt.	Length of exposure (hr)	No. isolated	Total No. tested*	Fraction of total tested containing any sensitive animals	Fraction of total tested containing only sensitive animals†
1	0.167	40	40	0.05	0.00
1	0.250	46	46	0.02	0.00
1	0.500	49	49	0.43	0.00
1	1.000	42	42	0.48	0.00
1	2.000	50	50	0.56	0.00
1	4.000	49	49	0.12	0.00
1	8.000	49	19	0.68	0.82
2	1.000	39	88	0.95	0.08
2	2.250	38	38	0.97	0.84
2	4.000	39	31	1.00	0.82
2	6.250	88	16	1.00	0.75
2	24.000	40	1	1.00	0.00

* Differences in the number isolated and the number tested are due to mortality.

† Clones containing only sensitive animals do not regain killing ability even when grown at one fission per day for three weeks. These clones, then, may be considered as having been derived from animals in which kappa was completely destroyed.

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[1] This investigation was supported by Indiana University and by Rockefeller Foundation grants in aid of research on protozoan genetics at Indiana University. The nitrogen mustard was supplied by Dr. Richard A. Ormsbee, of the Sloan-Kettering Institute for Cancer Research.

[2] National Institutes of Health predoctoral fellow.

at which temperature kappa can multiply faster than the animals. Those which contain at least one particle of kappa produce progeny with the full number and so yield killer clones. Those containing no particles remain sensitive and yield sensitive clones. This provides a means for calculating the number of kappa particles present in the original killer animal. The number of kappa particles present, on the average, in the progeny of a killer animal subjected to the expansion technique may be calculated by the approximate relation $P_0 = e^{-m}$, where P_0 is the proportion of individuals with no particles, m is the mean number of kappa particles per animal, and e is the base of natural logarithms (*1*).

If inactivation of kappa particles has occurred in animals exposed to nitrogen mustard, one can measure the extent to which this has occurred by comparing the mean number of particles in the progeny of exposed animals to that in the progeny of normal killer animals subjected to the expansion technique.

This comparison between animals exposed to nitrogen mustard (0.20 mg/ml) and animals exposed to buffer alone (controls) for a period of 7 min was made in experiment 3. A fresh solution of nitrogen mustard hydrochloride in phosphate buffer (pH 6) was made up twice as concentrated as was desired for the exposure. One drop of this solution was used immediately by adding it to an equal-sized drop of buffer containing the animals in a depression slide. The two drops were mixed quickly by agitating the slide, and after 7 min the animals were removed, washed three times in fresh culture fluid, isolated, and placed at 33.8° C for rapid fission. The exposed animals underwent seven fissions, and the controls underwent eight fissions. The results of carrying out these procedures on seven exposed and nine control animals from the same clone are given in Table 2.

TABLE 2

EFFECT OF NITROGEN MUSTARD ON THE NUMBER OF KAPPA PARTICLES IN KILLER ANIMALS

Animal No.	No. isolated and tested	Fraction sensitive	Mean No. of kappa particles
Exposed			
1	127	0.724	0.323
2	118	0.797	0.227
3	115	0.765	0.267
4	127	0.874	0.135
5	118	0.780	0.248
6	118	0.797	0.227
7	117	0.667	0.405
			Avg 0.261
Control			
1	238	0.236	1.44
2	99	0.222	1.42
3	98	0.092	2.39
4	98	0.143	1.95
5	98	0.122	2.10
6	94	0.106	2.24
7	27	0.148	1.91
8	29	0.138	1.98
9	24	0.167	1.79
			Avg 1.91

From the proportions of sensitive animals produced in the two series shown in the table, one may calculate that the average mean particle number for the progeny of the control animals was 1.91, whereas that for the exposed animals was 0.261. Since the controls went through one more fission than the exposed animals, the control value of 1.91 particles per animal must be doubled to make the value comparable to that found in the animals exposed to the action of nitrogen mustard. The percentage of kappa remaining after exposure is then $\frac{.261 \times 100}{2 \times 1.91} =$ 6.8%.

Experiments carried out using different lengths of exposure to nitrogen mustard indicate that the longer the exposure, the greater the percentage of kappa particles inactivated.

This procedure cannot be placed on an accurate quantitative basis at the present time because the effects of temperature alone on kappa have not been thoroughly investigated. There should be a way to correct for the effects of temperature after these have been studied in detail.

The results reported here were confirmed with the aid of the light microscope, using the methods of Preer (*3, 4*). The cytoplasm of killer animals contains Feulgen-positive particles which are not found in sensitive animals, and which parallel the behavior of kappa. The numbers of these particles exhibited by animals exposed to nitrogen mustard were much smaller than the numbers found in untreated animals. There then seems little doubt but that the staining reaction associated with kappa and its activity as regards the killer character are destroyed by the action of nitrogen mustard.

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A New Method for the Study of Submicroscopic Spaces

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Proceeding with their research on the optical properties of osseous substance, Dallemagne and Melon (*2*) attempted to obtain diagram curves of structural double refraction of the organic constituent of bone. Since the results, which will be published, have shown anomalies in the general aspect of the diagrams, we have been looking for a different technique for scanning the submicroscopic

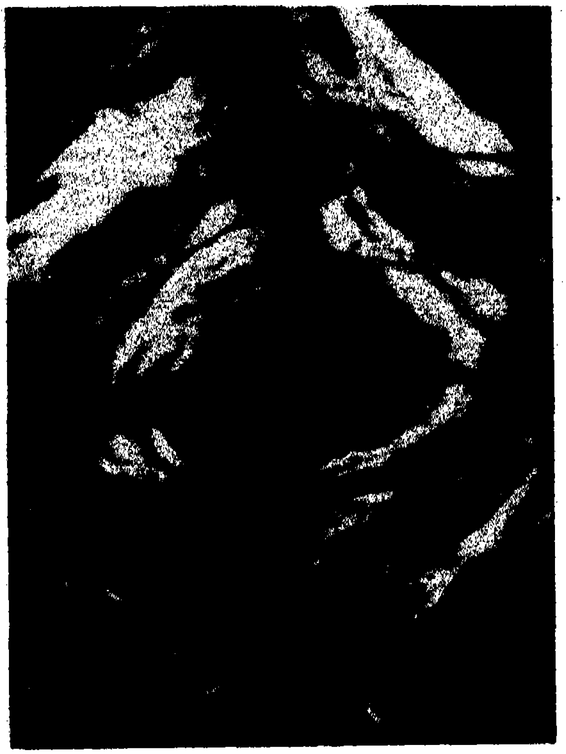

FIG. 1. Mineralized bone embedded in methyl methacrylate (polarized light).

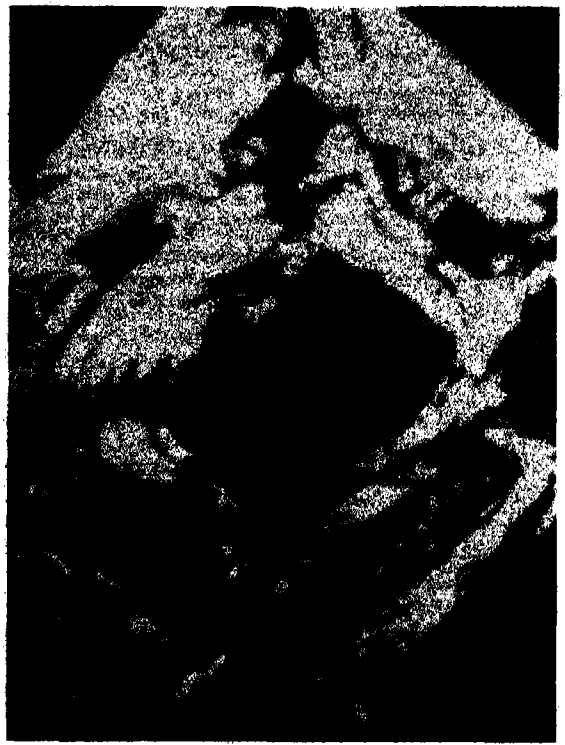

FIG. 2. The same material after treatment by hydrochloric acid, i.e., the "bone ghost" (polarized light).

spaces occupied by the organic substance in bones.

Slices of dry bone (200–300 μ thick) were sawed, then boiled (290° C) in anhydrous glycerol containing 6% KOH, until no trace of organic substance remained, according to Gabriel's method (*3*).

The bone slices were then carefully washed with distilled water, dried, and embedded in methyl methacrylate according to the technique of Coudert and Baud (*1*).

The preparations immersed in the pure monomer were placed in a vacuum until no more air bubbles escaped. Afterwards the preparations were introduced into slightly polymerized methacrylate and left for 12–24 hr at 56° C in airtight containers in the presence of benzoyl peroxide; the polymerization of the plastic was then accomplished.

The Plexiglas block was abraded on both faces by a grindstone until the embedded specimen reached the surface; it was then polished.

Examined under the microscope, both in ordinary and polarized light, the object showed, of course, the usual picture of mineralized osseous substance. Between crossed Nicols, it showed a retardation corresponding to impregnation with a medium having a refractive index of 1.490, which is the refractive index of polymerized methyl methacrylate (Fig. 1). The specimen was then immersed in a solution of normal hydrochloric acid and kept there until no more gas escaped, thus showing that all the carbonate was converted into chloride and that the mineral substance of bone had completely disappeared.

In fact, after this treatment, we cannot detect traces of bone when the plastic block is dissolved in acetone. However, such preparations, free from the initially embedded mineral substance, still look like ordinary osseous slices. Actually, this appearance is due solely to methyl methacrylate deposited in the submicroscopic spaces of mineralized bone. Thus, we have a "bone ghost."

In polarized light, we observe a picture topographically identical with the one obtained before hydrochloric destruction of the mineral substance (Fig. 2).

On the one hand, methacrylate becomes set in the submicroscopic spaces originally occupied by the organic constituents which are liberated through deproteinization; on the other hand, the mineral particles removed by hydrochloric acid leave free spaces that can thereafter be filled with liquids endowed with a different refractive index.

By means of such casts, it is possible to establish structural double refraction curves without fear of getting results spoiled by accidental influences (swelling, alteration by reagents, etc.).

The results of our optical research on "bone ghosts" will be published in detail elsewhere.

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Levels of Adaptation and Brightness Changes During Color Adaptation

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In an article which appeared recently in *Science* (*3*), Jozef Cohen has restated the major generalizations which summarize his data on color adaptation (*2*). Intensity, according to these generalizations, increases during color adaptation.[1] The increase, while independent of the hue of the stimulus, is dependent on its saturation and intensity. The general conclusion concerning the change in intensity stands in direct contradiction to the findings of a number of earlier investigators, who usually concluded that brightness (intensity) decreased rather than increased during the course of color adaptation (*1, 6, 7, 8*).

Cohen is well aware of this major discrepancy. He is also aware of the lack of complete agreement among previous investigators concerning other aspects of color adaptation, and he reports (*3*) an experiment designed to determine the source of the discrepancies. Most investigators have described their stimuli only in terms of color appearance. Cohen, therefore, tested the hypothesis that color adaptation of the eye is a function of the spectral composition of the stimulus and not of its tristimulus values (or appearance). Although the stimuli used by different earlier investigators may be comparable as regards tristimulus values, unrecognized differences in the physical compositions of various stimuli might have led to different adaptive effects. Cohen's experimental results were, however, negative. Stimuli of different spectral distributions but of the same tristimulus values produced no appreciable differences in color adaptation. Although this finding is not without its own intrinsic interest, the discrepant results concerning brightness changes during color adaptation still remain unexplained.

An analysis of the experimental methods and procedures used by most investigators, including Cohen, suggests an alternative explanation in terms of differential adaptation effects. The specific aim in color adaptation studies of this sort is to determine the manner in which a visual sensory effect, produced by a test stimulus of fixed intensity (luminance) and spectral distribution, varies with continued exposure. The variation in brightness, for example, is measured by equating to the test field after various times of exposure a comparison stimulus of variable intensity which stimulates a spatially separate retinal area in either the same or the other eye. Changes in the matching intensity of the comparison field are then taken as measures of the adaptive effect in the test area.

Unfortunately, however, in studies of this sort the responses evoked in the comparison area are, like those of the test area, also conditioned by initial and subsequent states of adaptation. Even if one were to assume, as Cohen does in his experiments, that a static or equilibrium state can be maintained in the comparison area during the course of the measurements, the initial level of adaptation of the comparison area still exerts a decisive influence upon the result. Visual comparisons between two discretely stimulated retinal areas depend not only on physical stimuli but upon the respective adaptation levels of both areas. Craik, in an extensive study of the effects of adaptation on brightness, has given a striking experimental demonstration of the extent of this dependence: ". . . an illumination of 3 e.f.c. presented to the dark-adapted left eye is judged subjectively equal to the adapted brightness of 15,000 or 75,000 e.f.c. presented to the right eye" (*5*, p. 239).

Since brightness equations made during the course of color adaptation depend on the relative adaptation levels of the visual test area whose adaptive changes are being measured and the visual comparison area which is used to measure these changes, the conflicting results which have been reported may very probably be due to different relations between these two levels in different experiments.

An examination of experiments in which a decrease in brightness of the test area during color adaptation is reported shows that the retinal comparison area is adapted to a lower illuminance level than the test area. Except for flash exposures necessary to make a color match to the test field, the comparison area is unstimulated during adaptation to the test color. The comparison area is in effect dark-adapting. Since its sensitivity, relative to that of the test area, is increasing with time, it is therefore to be expected that less and less light will be required for an equation to the test brightness.

It follows directly that opposite effects should occur if the adaptive levels and consequently the relative sensitivities of the two areas are reversed. With the adapting illuminance of the comparison area higher than that of the test patch, the intensity required for a match would be expected to increase during adaptation, as it did in Cohen's experiments. Were this one of his experimental conditions, the unexpected direction which his results took might readily be explained. In his experiments, in contrast to other investigations, the retinal comparison area was continuously stimulated during the adapting period by what he calls a neutral "*gray of medium brightness*" (*2*, p. 100). Unfortunately, the intensity level is not specified. It is asserted simply that "the patch upon which the match was made underwent little, if any, change, i.e., the retinal processes were in equilibrium'' (*2*, p. 109). In the absence of precise specification of the adaptation levels of the test and comparison areas, the proposed explanation lacks experimental confirmation. The following experiments are intended to provide such confirmation.

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[1] Cohen uses the word *intensity* to specify both the psychological and physical dimensions. His conclusions, however, refer specifically to measured physical variations in a matching stimulus during color adaptation. Given certain known psychophysical relations between stimulus intensity and sensation, such measurements are frequently interpreted as indicative of changes in the psychological dimension, and to describe them the word *brightness*, rather than intensity, is more commonly used. For specifying the stimulus, *luminance* is preferable to *intensity*. Intensity is restricted to the specification of point sources, while luminance, measured in lamberts or foot lamberts, specifies the intensity per unit of projected area of source. (See Colorimetry Report, Reference 4.) Since the older work with which the present paper is concerned has been reported and discussed in terms of "stimulus intensity," this usage is retained in the present discussion to avoid confusion.

The apparatus used in these experiments was a form of monochromatic colorimeter. The field sizes and positions, pre-exposure times, and adaptation controls were identical with those used in the Cohen investigation (see *2* for details). Observations were binocular, with both the test and comparison fields viewed by each of the two eyes. Judgments, however, were restricted to one psychological dimension—namely, brightness. To test the effects on brightness equations of differences in the relative adaptation levels of the test and comparison areas, three separate color adaptation experiments were performed. The stimulus intensity of the test color was the same in all three experiments. The adapting intensity of the neutral comparison field, while always within a range which might be considered of medium brightness, was less than, equal to, or greater than that of the test field in the separate experiments. The general result for two observers is shown in Fig. 1.

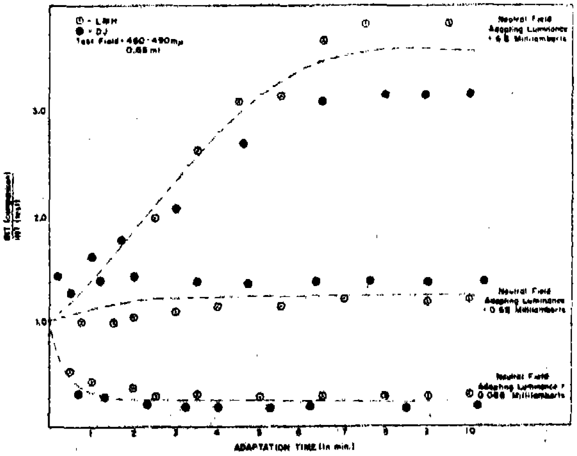

FIG. 1.

The lower curve in Fig. 1 indicates that the intensity of the comparison field necessary for a brightness equation to a test field of fixed stimulus intensity decreases with an increase in the time of adaptation. For this result, the achromatic adapting illuminance of the retinal comparison area was about one-tenth that of the colored test area. In the second experiment, on the other hand, the comparison area was adapted to approximately the same illuminance level as the test area. In this case, the curve shows that there was very little change in the matching intensity during the course of the adaptation period. Finally, the upper curve shows the matching intensity to increase with an increase in adaptation time. Here, the adapting illuminance of the comparison area was about ten times that of the colored test area. The increase in intensity under these conditions is similar to the result obtained by Cohen. The presumption seems warranted, therefore, that Cohen's experimental conditions were also comparable, and that the adapting illuminance of his retinal comparison area was, in fact, higher than that of his test area.

The results shown in Fig. 1 have been confirmed for each of two observers for two hues and two levels of test color illuminance. In all cases, the direction taken by the intensity function obtained is specific and reproducible, and depends on the relation between the adaptation levels of the retinal test and comparison areas. Fig. 1 conclusively demonstrates that the increase in intensity reported by Cohen cannot be accepted as a general law of color adaptation, any more than the decrease reported by other investigators can be so considered.

The curves presented in Fig. 1 are, in effect, equal brightness contours for different adapting levels, determined over specified periods of time and for particular experimental conditions. They reconcile the apparently discrepant results which have been interpreted as representing the manner in which brightness varies during the course of color adaptation. Actually, these curves cannot be taken to represent the manner in which the brightness attribute of a color varies with adaptation. They are functions which result from the *variations of two sensitivities,* variations in the test and comparison areas. The test sensitivity cannot be measured independently unless it is guaranteed that the comparison area is maintained at a constant level which is the same as the initial level of the test area. That a constant state of sensitivity can be maintained in the measuring area of the retina has long been doubted. To quote Almack, ''That this can be accomplished under such unusual circumstances as are imposed in an adaptation series is highly improbable . . . the choice of a method of equivalents is, we believe, an unfortunate one for rating loss of sensitivity by adaptation'' (*1*, p. 33). Further research alone will determine the validity of this point of view. It must again be emphasized, however, that even if the measuring area is demonstrated to be constant in sensitivity, results would still represent only relative changes from the specified initial sensitivity of the test area to subsequent states produced by adaptation to the retinal test illumination. Nevertheless, with complete specification of the experimental conditions, and with full awareness that results obtained in this manner represent events of a relational nature only, they, like any other measurable phenomena of color vision, provide much useful information. They require and will ultimately receive a necessary explanation in terms of underlying physiological processes.

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Measurement of Ionizing Radiations *in Vivo*[1]

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It is well known that the intensity of roentgen rays can be quantitatively measured by using a photomultiplier tube to pick up the light from a fluorescent screen exposed to these rays. It has occurred to various investigators that the light from the screen can be transmitted by various types of optical systems to the photocell. The optical system does not have to produce an image; in its simplest form it is an internally reflecting tube or light pipe. For roentgen-ray intensities used in therapy the amplification of the photomultiplier tube is far greater than is necessary for convenient measurement. This leeway suggested the possibility that the system would still be sensitive enough if the light pipe had a very small diameter and the fluorescent screen occupied a very small area at the end of the light pipe. It seemed possible that the light from the screen could be piped through a hypodermic needle or through small diameter Lucite or quartz rods for insertion in body cavities. Both these possibilities have been realized, permitting direct measurements of roentgen-ray depth doses *in vivo*. The first system tried used Lucite rods of ¼-in. and ⅛-in. diameter and about 10 in. long. With the view in mind that ultimately these rods could be used to transmit separate scintillation pulses instead of a steady light level, the ends of the rods were turned in a parabolic section as shown in Fig. 1; a small hole was drilled to the focus of the parabola and a very small amount of luminescent zinc sulfide phosphor was pushed into the bottom of the hole. The rods were then aluminized by evaporation and coated with a black varnish. The total internal reflection from an air interface could not be depended upon, since in use the rods are frequently immersed in water. This arrangement would give a much smaller number of scintillations than could be had by cutting the end of the rod square and coating it with a layer of fluorescent crystals, but much more light from a single scintillation could be collected and reflected along the inside of the rod. This arrangement still had plenty of reserve sensitivity for roentgen-ray dose measurements, thus permitting a very fine-grained resolution of isodose curves to be determined.

To illustrate the potentialities of this arrangement the isodose curves were plotted in a pail of water subjected to a beam of 65-kv roentgen rays. Fig. 2 shows the arrangement used. As the ⅛-in. rod still had plenty of reserve sensitivity, work was started to pipe light from a speck of fluorescent material through a hypodermic needle to the photocell. This worked very well with a No. 15 needle. An internally polished needle gave more than twice the response of an unpolished one. The needles were polished internally by running them back and forth on a stretched copper wire charged with polishing compound. In these tests the needles were not Lucite-filled. A few grains of zinc cadmium sulfide phosphor (Patterson type B) were stuck on a tiny tapered Lucite plug, which was forced in a short distance up from the point of the needle. The needle could be inserted into an animal in the usual manner. It was inserted into the abdomen of an anesthesized rat to measure the abdominal depth dose for 60-kv roentgen rays. The dose measured in the abdomen in this case was found to be about 60% of the surface dose. The wall of the needle absorbed an undetermined amount of radiation, but this had no effect on the relative readings or on the ability of the device to be calibrated for any particular voltage quality of radiation. The luminosity of the screen per r-unit per minute depends on voltage quality and falls off considerably for radium γ -rays. A low atomic number phosphor showing only Compton scattering absorption should have a calibration independent of voltage quality but will produce a much smaller total luminosity than the highly efficient known phosphors containing higher atomic number elements. However, zinc sulfide should be considerably better than zinc cadmium sulfide in this respect, since for voltages higher than the 100-kv range the K energy level of Zn is only about 9.5

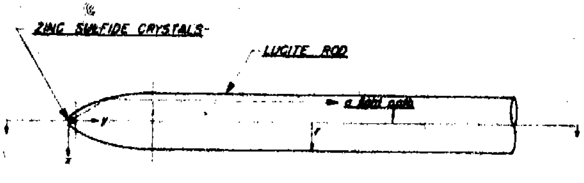

FIG. 1.

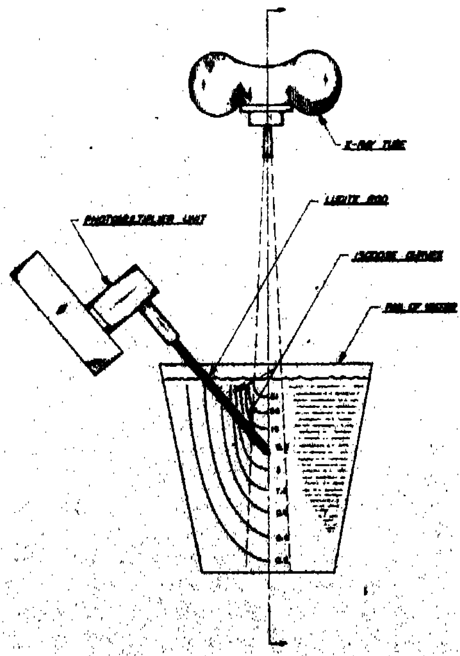

FIG. 2.

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[1] This paper is based on work performed under Contract No. AT-04-1-GEN-12 between the Atomic Energy Commission and the University of California at Los Angeles.

kv. Although the photomultiplier tube (1P21) is more sensitive to the blue light from zinc sulfide than from the yellow-green light from zinc cadmium sulfide, the latter gave more response at 60 to 80 kv, presumably because of its greater absorption.

The experiments with the long Lucite rods were performed without any amplifier added to the photomultiplier tube. An amplifier of current gain of about 10^5 was constructed and used to observe the alpha particle pulses. This amplifier was not a d-c amplifier, so that it could not be used for measuring a steady luminosity level unless a mechanical chopper were used to interrupt the light entering the photomultiplier. However, it was easy to observe the half-wave pulses of X-rays from self-rectified X-ray tubes, even at extremely low levels. The intrinsic noise level, mostly due to shot effect from the thermionic emission of the photocathode of the photomultiplier tube, was easily observable with the full gain of the added amplifier. The extra gain is necessary to pick up alpha particle scintillations through the hypodermic needles and scintillations caused by beta rays.

Alpha particle scintillations on the zinc cadmium sulfide phosphor were so high as compared with the noise level that it was fairly easy to observe scintillations through the polished No. 15 needle. Further work is in progress to improve this technique and investigate the possibilities of measuring the local concentration of beta activity of radioisotopes *in vivo*. It has been found possible to turn Lucite rods of sufficiently small diameter to slide inside a No. 15 needle. These are coated with evaporated aluminum and a few crystals of fluorescent material are stuck on one end. The method of insertion is to slide them into the needle so that the screen end is slightly retracted from the beveled end of the needle. The needle is inserted to proper depth and then the Lucite rod is pushed on so that the screen end slightly protrudes into the tissue. One-mm-diam optically clear quartz rods gave even better results than the Lucite, but they have the disadvantage of being fragile.

Concerning the Specificity of Chicken Pancreas Conjugase[1]

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In a previous paper of this series (*1*), the conclusion was reached that chicken pancreas conjugase should be classified as γ-glutamic acid carboxypeptidase. The minimum requirements for the length of the peptide chain of the substrate could not have been established at that time. While it was suggested that pteroyl-γ-diglutamate was the end product of the reaction, the possibility of premature termination of the reaction, due to inhibition by the products formed, was not excluded.

We were able to study some recently synthesized derivatives of pteroylglutamic acid.[3] The methods used were the same as those previously described (*1*). The results are summarized below:

Substrate	*Equivalents of glutamic acid recovered*
Pteroyl-α-diglutamate	0 (or traces)
Pteroyl-γ-diglutamate	0 (or traces)
Pteroyl-α-α-triglutamate	0.0–0.2
Pteroyl-γ,γ-triglutamate	0.4–1.0
p-Aminobenzoyl-γ-γ-triglutamate	0.5–1.0

Since pteroyl-γ-diglutamate was not attacked by the enzyme, it represents the end product of digestion of the substrate by chicken pancreas conjugase. These data confirm our previous hypothesis and are in agreement with the findings of J. J. Pfiffner[4] who isolated the diglutamate from a digest of pteroylheptaglutamate with this enzyme. The minimum requirement for the number of glutamic acid residues for the substrate was, therefore, established at *three*.

In three out of five experiments with α,α-triglutamate, free glutamic acid was recovered. But the speed of hydrolysis of the alpha linkage was less than one-half that for the gamma linkage. Contrary to our previous conclusion, it appears that the chicken pancreas conjugase hydrolyzes the gamma linkage *preferentially*, but not *specifically*. The final decision must be withheld, however, until a purer enzyme is available.

The rate of liberation of the microbiologically active substance at various stages of purification of the enzyme was also studied. The ratio of the units of activity found with heptaglutamate[5] as substrate divided by the units found with triglutamate varied from 1: 2 to 1: 8, with an average value of 1: 4.2. The calculated value for the diglutamate as the end product of the reaction is 1: 5; for the monoglutamate, 1: 3. In spite of considerable variation in experimental results, there was no tendency for a change in this ratio with increasing purity of the enzyme. This indicates that the liberation of microbiologically active substance from heptaglutamate is achieved by a single chicken pancreas conjugase, in contrast to the hog kidney conjugase, which has two components (*2*).

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[1] Aided by grants from the Donner Foundation, Inc., the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service, and the John and Mary R. Markle Foundation.

[2] On leave of absence from the Agricultural Institute, Pulawy, Poland.

[3] Obtained through the courtesy of E. L. R. Stokstad, Lederle Laboratories Division, American Cyanamid Company.

[4] Discussion at the Federation Meeting, Atlantic City, 1948.

[5] Heptaglutamate was obtained through the courtesy of Dr. J. J. Pfiffner, Parke, Davis and Company.

The Site of Action of Some Chemical Agents in Diminishing Normal and Excessive Muscle Tension[1, 2]

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The ability to reduce or to efface normal muscle tension or to lessen or abolish states of increased tension in muscle by the administration of drugs not only promises new knowledge concerning neuromuscular mechanisms, but also offers the possibility of aid to those suffering from disorders in which excessive muscular tension is a prominent and disabling feature. Furthermore, the determination of the exact site of action of chemical compounds on central neurons may ultimately lead to the successful utilization of appropriate substances in a number of disorders and diseases of the nervous system. Among the chemical agents which are known to possess the property of reducing muscle tension, curare and its derivatives, especially D-tubocurarine, the erythroidine compounds, and myanesin have received the most consideration.

The relaxing effect of curare on muscle tension is generally considered to be due to blockade of the motor nerve endings, and the degree of relaxation is thought to be in direct proportion to the number of motor nerve endings affected. Thus, the term curare-like action when applied to a drug is generally understood to mean that the drug is able to effect a partial or complete motor end-plate block. It is an important and well-known observation that partial blocking of the motor nerve endings in the extremity muscles can be attained with curare before paralysis of the respiratory mechanism. This affords a basis for the administration of curare in order to increase muscular relaxation during anesthesia for surgery.

The effect of curare on muscle function has been extensively studied by Bremer and his associates (*4–6*). They found that small doses temporarily abolished or considerably diminished the extensor rigidity of decerebrate cats, without significantly affecting phasic responses. This differential effect was explained on the hypothesis that light curarization activated the latent fatigue which existed at the neuromuscular junctions undergoing continuous bombardment by the tonic impulses, and hence altered the endings in such a manner that those impulses producing the rigidity were more easily blocked than those concerned with phasic responses. All available evidence supports the view that curare exerts its relaxing effect on muscle by action at the motor nerve endings. However, it should be possible to bring about reduction in muscle tension from action on central neural mechanisms. Our investigations on the two types of compounds, other than curare, which have been most used for reducing muscle tension—namely erythroidine and myanesin—have revealed the fact that in the case of these drugs a central action exists.

The erythroidine alkaloids were first isolated by Folkers and Major (*7*) and the initial pharmacological studies were made by Unna, Kniazuk, and Greslin (*11*), and Unna and Greslin (*12*). Of the Erythrina alkaloids isolated, both dihydro-β-erythroidine hydrochloride and β-erythroidine hydrochloride were found to possess a curare-like action, i.e., they abolished the contraction of striated muscle to excitation of its motor nerve fibers while the response to direct excitation of the muscle remained. In addition to confirming these findings of a curare-like action, we have found that the erythroidine compounds are able to exert a relaxing effect on muscle tension by central action. This effect is evident with doses considerably smaller than those producing complete end-plate blockade, but it becomes masked by larger doses which block transmission at the motor ending. In the normal nonanesthetized cat or monkey the administration of appropriate doses of either compound, orally or parenterally, produces muscular relaxation without abolishing spontaneous muscular movements or tendon reflexes. As the dose is increased, spontaneous movements disappear and greater relaxation of muscle tension is secured, but even with a considerable degree of muscular relaxation the tendon reflexes remain present, although reduced and easily fatigued, and the muscle contracts upon excitation of the muscle nerve. With still larger doses, the deep tendon reflexes are no longer elicitable, the animal becomes completely paralyzed, the muscle no longer responds to stimulation of its nerve, and paralysis of respiratory movements ensues. With the erythrodine alkaloids, the added amount of drug necessary to paralyze respiration after beginning muscular relaxation is large enough to afford a considerably greater margin of safety than in the case of D-tubocurarine and, as regards the two erythroidine compounds, the margin of safety is greater with β-erythroidine hydrochloride than with dihydro-β-erythroidine hydrobromide.

The amount of erythroidine required to produce different degrees of erythroidinization varies considerably and significantly as regards cat and monkey. In the nonanesthetized cat the amount of dihydro-β-erythroidine required to produce initial relaxation of muscle tension when given intravenously at the rate of 0.5 mg/min was found to vary considerably from animal to animal, ranging from 0.20 to 0.24 mg/kg. With continued administration, the degree of relaxation gradually increases until complete relaxation and abolition of spontaneous movements is attained with a dose of 0.4–0.5 mg/kg. Paralysis of respiratory movements ensues when 0.9–1.2 mg/kg has been injected. In contrast to these findings on cats, intravenous administration of the compound to monkeys (*Macaca mulatta*) at the rate of 1 mg/min was found to produce initial relaxation of muscle tension with 4–6 mg/kg. Practically complete relaxation with loss of spontaneous movements occurs when 7–8 mg/kg has been given, and respiratory movements cease after 8.2–11.4 mg/kg. It appears, therefore, that the amount necessary to produce a given effect varies considerably,

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[1] Aided by a grant from the National Foundation for Infantile Paralysis.

[2] The erythroidine compounds were supplied by Merck and Co, and the myanesin by E. R. Squibb and Sons.

not only from genus to genus, but also among individuals of any one species.

For the initial studies of the effect of these drugs on increased muscle tension, the standard preparation of the decerebrate cat was utilized. In such an animal it has previously been shown by Smith (*10*) that the administration of either of the two erythroidine compounds causes a gradual and complete relaxation of the rigid extremities without abolition of the tendon reflexes and without paralysis of respiratory movements. The amount required to produce relaxation of muscle tension was found to be approximately the same as in the case of nonanesthetized animals. When the excessive tension is completely abolished, the tendon reflexes are still present and respiratory movements persist. Continued administration of the drug produces paralysis of respiratory movements with a dosage similar to that required in experiments on nonanesthetized animals. With the advent of respiratory paralysis, tendon reflexes are no longer elicitable even though adequate oxygenation is insured by artificial respiration. Retention of the tendon reflexes in the state of abolition of the abnormal muscular tension, and the finding that at this stage the muscle is excited by stimulation of its nerve, suggests the possibility that the initial relaxing effect of the erythroidine compounds is not due to motor end-plate block, but to action of the drug on the central nervous system. Further investigations support this view by revealing that the crossed extensor reflex is abolished before loss of the knee jerk, although in every instance the knee jerk is diminished and exhibits the fatigability seen when the compounds are administered to nonanesthetized animals.

We next directed our attention to myanesin (*o*-toloxy-1,2-propanediol) in order to determine if it possessed a more discrete differential action on neuromuscular mechanisms than had been observed with erythroidine. This compound, when administered in appropriate amounts, has been shown by Berger and Bradley (*1, 2*) and Berger (*3*) to produce muscular relaxation and paralysis in animals anesthetized with chloralose without cessation of respiratory movements and without abolition of the knee jerk. They also found that contraction of the muscle through excitation of its nerve was not abolished except with doses larger than those necessary to produce paralysis of the extremities. Our investigations designed to yield information concerning the locus of action of the drug were first conducted on nonanesthetized cats. Administration of an aqueous solution of myanesin intravenously at the rate of 10 mg/min was found to produce a progressive generalized decrease in muscle tension, resulting in its complete abolition and in the disappearance of all spontaneous movements when approximately 125 mg/kg had been injected. At this stage, respiratory movements continued and the knee jerks were still present, but the flexor withdrawal reflex to noxious cutaneous stimuli was abolished.

In experiments employing decerebrate cats, it was found that myanesin, like erythroidine, produced a progressive relaxation of the muscle tension to the point of complete abolition. The amount required was considerably less than that necessary to abolish tension in the nonanesthetized animal. Even at the stage of complete relaxation, the muscle responded to stimulation of its nerve and knee jerks were elicitable, although both crossed extensor reflex and flexor reflex were abolished.

Analysis of the above experiments naturally led to the conclusion that myanesin had a differential action on central mechanisms, leaving intact the myotatic reflexes as exemplified by the knee jerk, but rendering inactive the reflex path for the flexor and crossed extensor reflexes. Further delimitation of the field of activity was attained by use of spinal animals. In spinal cats, with level of transection through the lower thoracic region, appropriate amounts of myanesin were observed to exert the same discrete differential effect on the spinal reflexes as in the decerebrate animal.

The interpretation of these results in the light of present day concepts of spinal cord structure and function affords information even more definitive concerning the probable locus of action. Current concepts of functional organization of the spinal cord, largely influenced by the investigation of Lloyd (*8, 9*), hold to the view that the crossed extensor reflex, the flexor withdrawal reflex, and other somatic reflexes elicited in response to cutaneous stimuli are mediated over pathways containing internuncial neurons interposed between the entering afferent fibers and the motor neurons innervating the reacting muscles. On the other hand, myotatic reflexes, of which the knee jerks and ankle jerks are well known examples, are considered to be effected by the incoming afferent impulses exciting the somatic motor neurons directly without the intervention of interneurons. Inasmuch as our experiments clearly demonstrate that these several responses which at present are considered to involve internuncial activity are abolished by erythroidine and myanesin in appropriate amount, while the myotatic reflexes remain in effect, it seems likely that both drugs are able to exert a relaxing effect on muscular tension by action on spinal internuncial neurons in such a manner as to produce a partial or complete internuncial blockade. The precise manner by which this is brought about must be determined by further investigations.[3]

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[3] We have recently found that the administration of myanesin to the anesthetized cat abolishes movements of the extremities elicited by electrical stimulation of the motor cortex.

Comments and Communications

Distinction between Acetylcholine-Esterase and Other Choline Ester-splitting Enzymes

During the past few years, choline ester-splitting enzymes have been studied by many investigators. One of the problems involved has been the question of the existence of an esterase specific for acetylcholine—a question of considerable interest in view of the important physiological function of this ester. Much information has been obtained and the facts are, with a few exceptions, in good agreement. However, the picture may appear confusing, due mainly to the lack of a consistent classification and terminology. It is the purpose of this note to propose a classification and a terminology which may contribute to clarifying the situation.

The question of the existence of an esterase specific for acetylcholine was first raised by Stedman, Stedman and Easson (*Biochem J.* 1932, 26, 2056). These investigators thought that the enzyme which they prepared from horse serum was specific for choline esters, although not for acetylcholine, since it split butyrylcholine at a higher rate than acetylcholine. Later experiments, however, have shown that the esterases present in some sera are not specific for choline esters, although they split them faster than noncholine esters (VAHLQUIST, B. *Skand. Arch. Physiol.*, 1935, 72, 133; and GLICK D. *J. biol. Chem.*, 1938, 125, 729; 1939, 130, 527; 1941, 137, 357). Alles and Hawes found that the esterase in red blood cells differs markedly from the serum esterase (*J. biol. Chem.*, 1940, 133, 375). The former is inhibited by high concentrations of acetylcholine in contrast to the latter; it hydrolyses acetyl-β-methylcholine, which is not split by serum esterase (Glick, *op. cit.*). Richter and Croft (*Biochem J.*, 1942, 36, 745) confirmed these observations and found the red cell esterase highly specific for acetylcholine. Brain esterase was found to be similar to the red cell esterase (ZELLER, E. A. and BISSEGGER, A. *Helv. chim. Acta*, 1943, 26, 1619; NACHMANSOHN, D. and ROTHENBERG, M. A. *J. biol. Chem.*, 1945, 158, 653). These two esterases do not split benzoylcholine (MENDEL, B., MUNDEL, D. B., and RUDNEY, H., *Biochem. J.*, 1943, 37, 473). Testing a variety of esters and esterases of different tissues, Nachmansohn and Rothenberg showed that the esterase in all conductive tissue, nerve and muscle, and in erythrocytes has a number of well-defined properties. In addition to a well-defined optimum acetylcholine concentration, described previously, they found that the enzyme splits propionylcholine at the same or at a lower rate than acetylcholine, whereas butyrylcholine was shown to be split at a very low rate or not at all. At a concentration optimal for acetylcholine, noncholine esters were split at a very low rate or not at all. The observations included a virtually pure esterase preparation obtained from the electric tissue of *Electrophorus electricus*. In striking contrast to this type of esterase, esterases of other tissues, like that of serum, split propionylcholine at a higher rate than acetylcholine and butyrylcholine at a higher rate than propionylcholine.

The importance of studying the enzyme activity as function of substrate concentration for all esters has been emphasized by K. B. Augustinsson (*Acta. physiol. Scand.*, 1948, 15, Suppl. 52). Testing the activity as function of substrate concentration, he found that the esterases from conductive tissue and erythrocytes have the same optimum substrate concentration for propionylcholine and butyrylcholine, whereas, e.g., for acetyl-β-methylcholine they have a different optimum (*J. biol. Chem.*, in press). Noncholine esters, like triacetin, show entirely different activity-substrate concentration relationships. At very high substrate concentrations, hydrolysis rate may be even higher than with acetylcholine.

From all these investigations it is obvious that there is a type of esterase which is highly specific for acetylcholine, although this specificity is relative and not absolute. Whereas the facts accumulated present a fairly clear picture, no agreement exists concerning the terms

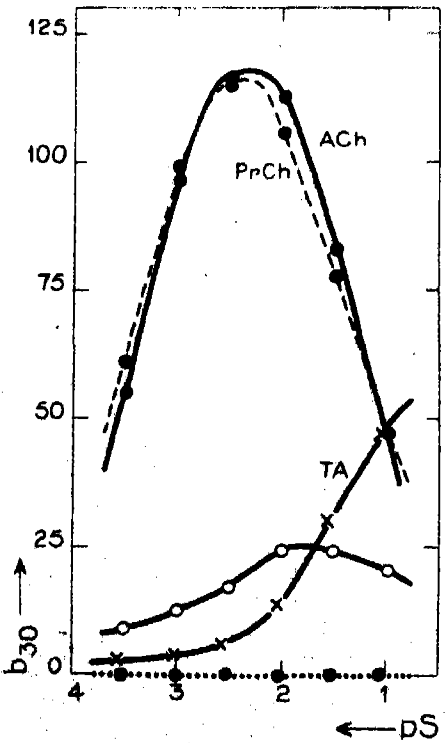

FIG. 1. *Acetylcholine-esterase.* Source: electric tissue of *Electrophorus electricus*. Activity-pS curves for the enzymatic hydrolysis of various esters.

● - - - - - - ● Acetylcholine (ACh);
● . . . . . . ● butyrylcholine (BuCh);
● — — — — ● propionylcholine (PrCh);
○———○ DL-acetyl-β-methylcholine;
×———× triacetin (TA).

used for the different types of choline ester-splitting enzymes. Zeller distinguishes the enzymes according to the material where they were first found and described. Nachmansohn and Rothenberg referred to the enzyme in conductive tissue and erythrocytes as a cholinesterase specific for acetylcholine, but a term distinguishing this type from other choline ester-splitting enzymes appears desirable. Augustinsson defined as cholinesterase all those esterases which, at substrate concentration optimum for acetylcholine, split this ester at a higher rate than any other ester. Since he included in this classification the serum esterase, this definition must be revised.

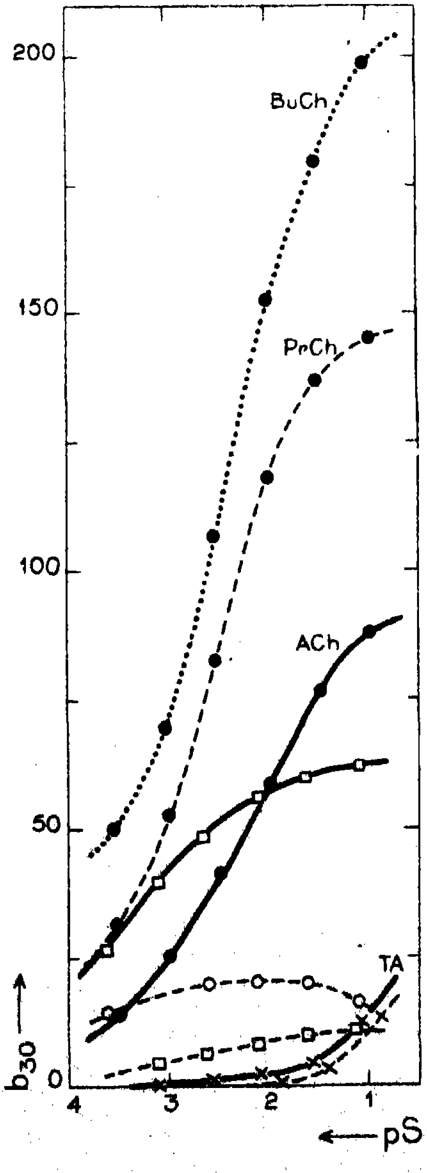

FIG. 2. *Cholinesterase.* Source: human serum. Activity -pS curves for the enzymatic hydrolysis of various esters. Symbols the same as in Fig. 1.

Mendel and his associates introduced the terms "true" and "pseudo" cholinesterase. In contrast to the finding of other investigators, Mendel and Rudney found an optimum rate of acetylcholine hydrolysis by brain esterase to be below 0.0002 M substrate concentration. This optimum rate, at an extremely low acetylcholine concentration, they consider to be the decisive difference of "true" as compared with the "pseudo" cholinesterase, for which they found an optimum of above 0.02 M. These data were based on inadequate techniques (NACHMANSOHN, D. and ROTHENBERG, M. A. *J. biol. Chem.*, 1945, 158, 653). The experiments were not carried out under optimal conditions, especially in regard to the salt concentrations (AUGUSTINSSON, K. B. *Acta physiol. Scand.*, 1948, 15, suppl. 52). Also, the expressions "true" and "pseudo" enzyme have met general opposition by enzyme chemists (GLICK, D. *Science*, 1945, 102, 100).

Since there exists a type of esterase with well-defined properties and highly specific for acetylcholine, we suggest the use of the term acetylcholine-esterase (ACh-esterase) for this enzyme. Its most outstanding characteristics may be summarized as follows: It has a high affinity to acetylcholine, that is, the Michaelis constant is small. The turnover number is high. No other ester is hydrolyzed at a higher rate. The enzyme splits propionylcholine at the same or at a lower rate, butyrylcholine, at a low rate or not at all. Noncholine esters are not split or at a low rate. The enzyme has a low affinity to these latter esters. If the enzyme activity is plotted against log M acetylcholine concentration, a bell-shaped curve is obtained, consistent with the theory of Haldane about inhibition of enzyme by excess of substrate (see Fig. 1). The ACh-esterase occurs in conductive tissue (nerve and muscle) and in erythrocytes. Esterases with similar characteristics occur in a few special cases, like snake venom and *Helix* blood (AUGUSTINSSON, K. B. *Acta physiol. Scand.*, 1948, 15, suppl. 52), although these enzymes have a few distinct features as compared with the ACh-esterase of conductive tissue.

The properties of acetylcholine-esterase make it possible to distinguish this enzyme from other esterases. There are other esterases, e.g., in some sera, and in the pancreas, which split choline esters at a higher rate than noncholine esters. According to the usual enzymological terminology, these esterases may be called cholinesterases, as was originally proposed by Stedman for the serum esterase. Their physiological substrate is at present unknown and so the name seems at least temporarily appropriate. These esterases as compared with acetylcholine-esterase have a high Michaelis constant for choline esters. They are not inhibited by high concentrations of acetylcholine. Hydrolysis rate increases with increasing length of the acyl chain (from acetyl to *n*-butyryl) (Fig. 2).

It is hoped that the classification and terminology proposed may help to avoid further confusion. The term ACh-esterase, moreover, will associate this type of enzyme with its physiological substrate, at least in nerve and muscle tissue, where a function of acetylcholine appears fairly well established.

KLAS-BERTIL AUGUSTINSSON
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Book Reviews

Contributions to the anthropology of the Soviet Union. (Publ. 3947.) Henry Field. (Compiler.) Washington, D. C.: Smithsonian Institution, 1948. Pp. vii + 244. (Illustrated.) $2.00.

This volume, which is a compilation of recent Soviet data pertaining to the archaeology and physical anthropology of the USSR, is certainly the most comprehensive and ambitious of Dr. Field's long and very impressive list of valuable publications dealing with the study of man in the lands administered by the Russians. Dr. Field acquired the bulk of his material in Moscow and Leningrad during June and July, 1945, when he was a delegate to the Jubilee Session celebrating the 220th anniversary of the founding of the Academy of Sciences of the USSR by Peter the Great. These meetings, known as the All-Union Conference on Archaeology, were attended by a total of 156 delegates. In chapter I, Dr. Field has ably summarized the scope and significance of the most important papers presented at this conference. Collectively, these reveal that Soviet scientists are now prepared to admit without reservation the fact that archaeological investigations in the USSR during the past twenty-five years have contributed a wealth of new and important material bearing on the problem of the origin of the Slavs and the development of humanity from Palaeolithic times to the Middle Ages.

V. V. Bunak, who prepared chapter II, has included brief accounts of the fossil human remains found at Teshik-Tash, Southern Bukhara, and Kiik-Koba, Crimea, as well as some general comments regarding current research on skeletal material from various sections of the USSR, racial studies in Siberia and the Caucasus, and investigations of a joint anthropological-medical nature on growth changes in the human body. Chapters III and IV are devoted entirely to archaeology, the former being a translation of a paper by P. P. Efimenko and N. A. Beregovaia published in 1941 on "Palaeolithic Sites in the USSR." It presents a comprehensive summary of some 304 Palaeolithic localities in European Russia and Siberia based on the data available during 1938; however, all bibliographic references have been deleted from the translation. Under the heading "Miscellanea Archaeologia," the title of chapter IV, Dr. Field has assembled a series of items of archaeological interest from the Ukraine, Crimea, Black Sea coast, Caucasus, Armenia, Don region, Volga region, Urals, Russian Turkestan, and Siberia. In many instances these supplement notes were previously published by the author on the same general subject.

More than one-half of the book (total: 131 pages) consists of a series of studies based on the results obtained by Soviet physical anthropologists, together with observations recorded by Dr. Field himself in the Soviet Union during September and October, 1934. The most important of these studies, which are grouped under the general heading "Miscellanea Anthropologia" (chapter V) concern the peoples of the Western Pamirs, the Mountain Tajiks, the peoples of Uzbekistan, the Kazakhs, the Turkomans, and the Turkish peoples of the USSR. Other sections of this chapter are devoted to a description of the so-called Tardenoisian skeleton from Fatma Koba, Crimea, a summary of the palaeo-anthropology of the Lower Volga area (third millenium B. C. to the third century A. D.), the results of various craniological studies, including 14th and 15th century Tartars, Kalmyks, Ulchi, Yakuts, Orochis, and Aleuts, as well as short discussions on the origin of the Mongols and Eskimos, and blood groups in the Caucasus and of the Turkomans. The extraordinary range and wealth of material presented here testifies to Dr. Field's broad understanding of racial problems, particularly those bearing on Asia. All American anthropologists will await with interest the forthcoming publication of his *Contributions to the anthropology of the Caucasus*. In the meantme, the Smithsonian Institution is to be congratulated for bringing out the present volume, and commended for the excellence of the format employed. This is a book which no student of either Old World prehistoric archaeology or physical anthropology can afford to be without.

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Readings in the history of psychology. Wayne Dennis. (Ed.) New York: Appleton-Century-Crofts, 1948. Pp. xi + 587. $4.75.

This is the first such volume of selected readings, all presented in the English language, to appear since 1912. It is timely in that psychology has changed much in the last forty years. The compiler has chosen 61 classics that are based mostly on investigation and experimentation. Articles are reprinted in full; monographs and books are represented by excerpts. The arrangement is chronological by date of publication, and full bibliographical data are given. Some readings are as short as one or two pages; none exceeds eighteen.

There are two readings from Aristotle; all the others date from the 17th century or later; half are more recent than Wundt's founding of experimental psychology in 1879. Thirty are 19th century and eighteen 20th century contributions, the latest by C. L. Hull in 1930. Two to four selections are made from the works of some of the outstanding figures in the history of psychology—for example, Thomas Young, E. H. Weber, Helmholtz, Galton, Cattell, Thorndike, Köhler, Lashley, and Binet and Simon. Such emphasis seems appropriate in assembling scientific material from a total of 46 contributors to the more immediate background of modern psychology as usually taught in American colleges and universities.

In arriving at his final selection, the compiler, on the basis of his own teaching experience, first drew up a list of 48 titles, which he submitted to a group of 14 psychologists for criticism and suggestions on serious omissions. The final list of 61 choices represents his attempt at a balance between the wealth of material and the space available in one volume. He frankly admits that "... many important contributions to psychology could not be included." Although some who teach psychology will doubtless discover regrettable omissions, they will, on the other hand, probably find here much if not most of what they would wish to have conveniently available to their elementary students. Historical classics in scientific literature become increasingly rare and original texts suffer from exposure to the wear and tear of reading by large classes. It is important that worthy classics should be reprinted in accessible form and the compiler and publisher have made a real contribution toward this end. The volume has a good index for names, but unfortunately has none for psychological topics. It has been planned more for supplementary use in course teaching than for individual study in working up the background of special fields and subjects in psychology. A bibliography of texts and articles on the history of psychology might appropriately have been included; however, general students of this modern scientific subject will benefit from the well-arranged compilation.

W. R. MILES

Yale University

Aufgabe der Psychologie: Eine Geschichte ihrer Probleme. (The Task of Psychology: A History of its Problems.) Paul v. Schiller. Vienna, Austria: Springer-Verlag, 1948. Pp. 233. $4.00.

This book is an enlarged and revised translation of a Hungarian original published in 1940 by the Hungarian Academy of Sciences. It endeavors to reestablish the unity of psychology by pointing out its historical centering about the concept of action (*Handlung*), with its prime emphasis on overt behavior and adjustment to environment rather than on the introspective aspect of human responses. The latter aspect is seen as subordinate to the former, somewhat in the manner of the American functionalists and of Bühler. Ancient and medieval writers, such as Plato, Aristotle, Augustine, and Thomas receive more than their usual share of attention, and with them the philosophical issues tied in with the history of psychology. The originality of the author is at its best in these chapters.

Much of the presentation of modern American writers, primarily such "molar behaviorists" as Tolman and Lashley, is obviously meant to be informative on a relatively elementary level and adapted to the needs of the author's Hungarian students—whose only practicable access to the type of foreign literature involved may well have been this book. After a discussion of psychoanalysis, behaviorism, *Gestalt* psychology and some of the older psychological systems, the author concludes with a general discussion of the role of psychological needs and motivation in the framework of action.

EGON BRUNSWIK

University of California at Berkeley

Storia naturale del sesso. Emanuele Padoa. Turin, Italy: Giulio Einaudi, 1948. Pp. 560. (Illustrated.) 2100 lire.

This book on the biology of sex, written during the war under very difficult conditions, is one of the most remarkable biological works that have come out in Italy during these years. Dr. Padoa, professor of biology at the University of Siena, has worked for many years in these problems and has contributed some fundamental researches to the problem of sex biology. He has done an excellent job in presenting here in a clear and simple way problems that are sometimes made very complex. One of the book's most outstanding features is its wealth of information; the reader finds here all the most interesting data on sex biology in plants and animals, always interpreted by the use of modern genetics. Problems of genetics of sex, cytogenetics, physiology of reproduction, phenotypic and genotypic sex determination, chemistry of sex hormones in vertebrates, experimental sex reversal, and sex evolution are all discussed.

To examine the subjects discussed in the chapter on genetic determination of sex, for example, there are sections on genetic determination of diplonts, crossing of a heterozygote with a recessive homozygote, numerical ratio of sex, sex in identical twins, sex chromosomes, inheritance of characters linked to sex (man, *Drosophila*, cat, *Melandrium*, chicken, butterflies), equilibrium of sex genes, genetic distribution in the gametophytes of the aplodiplonts, determination of sex with zygotic reduction, sex in hermaphrodites, and sterility in plants and animals. All the other nine chapters of the book provide just as thorough treatment of their subjects.

Another interesting feature of the book is its reporting of research on sex biology done in Europe during the war years and not yet well known in the United States—for example, the works of Hartmann and his school in Germany, on the physiology of reproduction in the echinoderms, and findings in the same field at the Zoological Station of Naples during the war years.

In spite of the vast amount of material, the real problem is never lost in details, but always emerges clear and vivid.

At the end of each chapter there are references to review articles and other collateral material, besides the references to original literature for those who wish to go more deeply into a particular subject.

This book may be well recommended both to biologists who want to keep informed of new problems and to students who want to become acquainted with this part of modern biology.

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Scientific Book Register

Burk, R. E., and Grummitt, Oliver. (Eds.) *High molecular weight organic compounds.* (Frontiers in Chemistry, Vol. vi.) New York: Interscience, 1949. Pp. ix + 330. (Illustrated.) $5.50.

Coburn, Alvin F., and Young, Donald C. *The epidemiology of hemolytic streptococcus during World War II in the United States Navy.* Baltimore: Williams & Wilkins, 1949. Pp. 229. (Illustrated.) $4.00.

Conn, Howard F., *et al.*, (Ed.) *Current therapy 1949: latest approved methods of treatment for the practicing physician.* Philadelphia: W. B. Saunders, 1949. Pp. xxxii + 672. $10.00.

Cournand, André, Baldwin, Janet S., and Himmelstein, Aaron. *Cardiac catheterization in congenital heart disease: a clinical and physiological study in infants and children.* New York (22): Commonwealth Fund, 1949. Pp. viii + 108. (Illustrated.) $4.00.

Coxeter, H. S. M. *The real projective plane.* New York: McGraw-Hill, 1949. Pp. x + 196. (Illustrated.) $3.00.

David, F. N. *Probability theory for statistical methods.* New York-London: Cambridge Univ. Press, 1949. Pp. ix + 230. $3.50.

Fine, Jacob. *Care of the surgical patient: including pathologic physiology and principles of diagnosis and treatment.* Philadelphia: W. B. Saunders, 1949. Pp. xvi + 544. (Illustrated.) $8.00.

Gates, Frank C. *Field manual of plant ecology.* New York: McGraw-Hill, 1949. Pp. xv + 137. (Illustrated.) $3.00.

Gerard, R. W. *Unresting cells.* (Reissue.) New York: Harper, 1949. Pp. xv + 439. (Illustrated.) $4.00.

Goetzel, Claus G. *Treatise on powder metallurgy: technology of metal powders and their products.* (Vol. 1.) New York: Interscience, 1949. Pp. xxvii + 778. (Illustrated.) $15.00.

Griffin, Carroll Wardlaw. *Inorganic quantitative analysis.* Philadelphia-Toronto: Blakiston, 1949. Pp. xiv + 368. (Illustrated.) $4.50.

Habell, K. J., and Cox, Arthur. *Engineering optics: the principles of optical methods in engineering measurement.* New York (19): Pitman Publ., 1948. Pp. xiv + 411. (Illustrated.) $7.50.

Hall, Marguerite F. *Public health statistics.* (2nd ed., rev.) New York: Paul Hoeber, 1949. Pp. xxvii + 441. (Illustrated.) $7.50.

Hardenburg, E. V. *Potato production.* Ithaca, New York: Comstock, 1949. Pp. xi + 270. (Illustrated.) $3.00.

Hartman, Frank A., and Brownell, Katharine A. *The adrenal gland.* Philadelphia: Lea & Febiger, 1949. Pp. 581. (Illustrated.) $12.00.

Hatch, Melville H. *A century of entomology in the Pacific Northwest.* Seattle: Univ. of Washington Press, 1949. Pp. v + 42. (Illustrated.) $1.50.

Hatcher, William H. *An introduction to chemical science.* (2nd ed.) New York: John Wiley, 1949. Pp. x + 449. (Illustrated.) $4.00.

Hunter, George W., and Hunter, F. R. *College zoology.* Philadelphia: W. B. Saunders, 1949. Pp. xi + 821. (Illustrated.) $5.50.

Kaufman, William. *The common form of joint dysfunction: its incidence and treatment.* Brattleboro, Vt.: E. L. Hildreth, 1949. Pp. xi + 208.

King, G. Brooks, and Caldwell, William E. *The fundamentals of college chemistry.* New York: American Book, 1949. Pp. viii + 536. (Illustrated.) $4.00.

Krantz, John C., Jr., and Carr, C. Jelleff. *Pharmacologic principles of medical practice.* Baltimore: Williams and Wilkins, 1949. Pp. xv + 980. (Illustrated.) $10.00.

Nicolai, Georg Fr. *La seguridad cientifica: cuatro discursos del metodo de las ciencias naturales.* Santiago: University of Chile Press, 1948. Pp. 245.

Rangappa, K. S., and Achaya, K. T. *The chemistry and manufacture of Indian dairy products.* Bangalore, India: Bangalore Prntng. & Pblg., 1948. Pp. vi + 189. Price Rs. 10/-.

Rider, Paul R. *Intermediate algebra for colleges.* New York: Macmillan, 1949. Pp. x + 242. $2.75.

Rosebury, Theodore. *Peace or pestilence: biological warfare and how to avoid it.* New York: Whittlesey House (McGraw-Hill), 1949. Pp. 218. $2.75.

Sommerfeld, Arnold. (Trans. by Ernest G. Straus.) *Partial differential equations in physics.* New York: Academic Press, 1949. Pp. xi + 335. $5.80.

Synge, John L., and Griffith, B. A. *Principles of mechanics.* (2nd ed.) New York: McGraw-Hill, 1949. Pp. xvi + 530. $6.00.

Weiser, Harry Boyer. *A textbook of colloid chemistry.* (2nd ed.) New York: John Wiley; London: Chapman & Hall, 1949. Pp. x + 444. (Illustrated.) $5.50.

Wilson, A. J. C. *X-ray optics: the diffraction of X-rays by finite and imperfect crystals.* London, W.C.2: Methuen, 1949. Pp. vii + 127. (Illustrated.) 6/.

Zworykin, V. K., and Ramberg, E. G. *Photoelectricity and its application.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xii + 494. (Illustrated.) $7.50.

————————. *Child health services and pediatric education.* (Report of the Committee for the Study of Child Health Services, American Academy of Pediatrics, with the cooperation of the U. S. Public Health Service and the U. S. Children's Bureau.) New York: Commonwealth Fund, 1949. Pp. xxv + 270. (Illustrated.) $3.50.

NEWS and Notes

An amendment to the independent offices appropriations bill HR 4177, calling for full FBI investigations of all fellows under the program of the Atomic Energy Commission, has been prepared by Senator O'Mahoney. Scheduled for introduction when the bill comes before the Senate, it reads as follows: "No part of any appropriation contained in this title for the Atomic Energy Commission shall be used to confer a fellowship on any person who advocates or who is a member of an organization or party that advocates the overthrow of the Government of the United States by force or violence or with respect to whom the Attorney General finds, upon investigation and report by the Federal Bureau of Investigation on the character, associations, and loyalty of whom, that reasonable grounds exist for belief that such person is disloyal to the Government of the United States: *Provided,* That any person who advocates or who is a member of an organization or party that advocates the overthrow of the Government of the United States by force or violence and accepts employment the salary, wages, stipend, or expenses for which are paid from any appropriation contained in this title shall be guilty of a felony and, upon conviction, shall be fined not more than $1,000 or imprisoned for not more than one year, or both: *Provided further,* That the above penal clause shall be in addition to, and not in substitution for, any other provisions of existing law."

Another amendment to the Atomic Energy Act of 1946 was introduced by Senator McMahon as S. 2215 on July 7, placing further limitations upon the Commission. This bill proposes that "the authorization of Congress shall be required . . . with respect to the total amount of money and contract authorization annually requested . . . before the appropriation of any funds for the Commission's use shall be authorized." By means of this amendment Congress would, in effect, acquire direct control over every "substantial activity, project, or operation undertaken or to be undertaken in accordand with the provisions of this Act."

The National Science Foundation bill, H. R. 4648, which has been approved by the Committee on Interstate and Foreign Commerce, is being held up in the Rules Committee. Apparently that committee is reluctant to bring the bill to the House of Representatives for vote because of the current economy drive. Members of the Rules Committee are: *Democrats*—Adolph J. Sabath (Illinois) chairman, E. E. Cox (Georgia), Howard W. Smith (Virginia), William M. Colmer (Mississippi), Ray J. Madden (Indiana), John E. Lyle, Jr. (Texas), John McSweeney (Ohio), and James J. Delaney (New York); *Republicans*—Leo E. Allen (Illinois), Clarence J. Brown (Ohio), James W. Wadsworth (New York), and Christian A. Herter (Massachusetts).

Detlev W. Bronk, chairman of the National Research Council and president of Johns Hopkins University, delivered the annual Croonian Lecture of the Royal Society of London on June 30. Dr. Bronk spoke on the rhythmic action and respiration of nerve cells.

Carroll L. Birch, associate professor of blood diseases and tropical medicine at the University of Illinois Medical School, has left on a six-month expedition to the west coast of Africa. During her stay in Africa, Dr. Birch will make side trips to the Belgian Congo, the Gold Coast, Liberia, and Nigeria, and into remote sections of French Equatorial Africa to obtain specimens of disease-spreading organisms for use in courses at the medical school. She will also do research work on natives with various forms of malaria and sleeping sickness.

Frank G. Young, chairman of the Department of Chemistry, University College, London, has been appointed professor of chemistry at Cambridge University. Dr. Young recently visited the U. S. to participate in a symposium on diabetes at the Army Medical Department Research and Graduate School.

D. J. Hughes, division director of the Experimental Nuclear Physics Research Division, Argonne National Laboratory, has resigned to accept a position as senior physicist at the Brookhaven National Laboratory, Upton, New York.

J. K. F. Holtfreter, of the Zoology Department at the University of Rochester, will be guest lecturer for the summer session at the Department of Histology and Embryology of the Faculty of Medicine, University of Montevideo, Uruguay.

Visitors to U. S.

Recent visitors at the National Bureau of Standards were **H. Powell,** research chemist, Anglo *Iranian Oil Company, Research Station,* Sunbury-on-Thames, England; **James Brown,** lecturer in mechanical engineering and applied mechanics at the Royal Technical College of Glasgow, Scotland; **Hernando Posada,** general manager, Instituto de Crédito Territorial, Bogota, Colombia; **Gerardo A. Imperial,** professor of chemistry at Silliman University, Philippine Islands; **Gordon Weston,** assistant director of the British Standards Institution, London; **W. W. Vardssieau,** chemist, National Research Council of Holland; **Virginia E. Marting,** research assistant, Cavendish Laboratory, Cambridge University, England.

The National Vitamin Foundation has announced six new grants-in-aid for research in problems of nutrition in health and disease. The awards, effective July 1, were made to *Leonard J. Goldwater* and *Maurice E. Shils,* Columbia University School of Public Health; *Winslow T. Tompkins,* Pennsylvania Hospital, Philadelphia; *Ernest Geiger,* University of Southern California School of Medicine; *Robert W. Heinle* and *Thomas P. Singer* (separate grants), both of Western Reserve University

School of Medicine; and *Willard A. Krehl*, Yale University.

The Carnegie Corporation has made a three-year grant of $90,300 to the University of Minnesota for research in the social sciences, involving the fields of political science, psychology, and anthropology. The program will be carried on through the university's Laboratory for Research in Social Relations. Further information may be secured from John G. Darley, Assistant Dean of the Graduate School, University of Minnesota, Minneapolis 14.

The Honor Scroll Award of the American Institute of Chemists will be presented to Otto Eisenschiml, president of Scientific Oil Compounding Company, at a meeting of the Chicago Chapter on October 7. Dr. Eisenschiml is being honored for his work in the chemistry of vegetable oils.

The National Research Council of Canada has awarded fellowships totaling $75,500 to 38 graduates in medicine to enable them to pursue postgraduate research during 1949–50. The fellowships vary in amounts from $1,500 to $2,500. The grantees represent 11 universities, including one in Australia, one in Scotland, and one in China. Eight of the research centers are located in Canada, five in the United States, and one in England.

Colleges and Universities

A group of Princeton University physicists will spend six weeks aboard the *U.S.S. Norton Sound* making cosmic ray experiments at sea. The experiments will be conducted by two scientifically independent groups under the direction of John R. Winckler and George Neilson Whyte. The Winckler group will use balloons for a determination of the energy distribution of the primary cosmic rays and relative number of rays having positive and negative electrical charges. The Whyte group will undertake two experiments: number and size of nuclear explosions due to cosmic ray particles as a function of altitude, and determination of the number of slow neutrons present in the atmosphere as a function of altitude. It is expected that information obtained will contribute toward determining the source of cosmic rays and give basic information necessary for the study of very high energy nuclear interactions and the forces which hold the nucleus together.

The New York University College of Medicine has received a shipment of snails infected by a parasite which transmits the tropical disease schistosomiasis. Claude H. Barlow, parasitologist, brought the snails from Egypt, where they infest the irrigation canals, serving as host for the larva worm. Dr. Barlow deliberately infected himself with the disease several years ago in order to study it and received the Medal for Merit last year in recognition of his contribution to science. Fifty-four percent of all Egyptians are affected by the disease. The university will conduct an intensive research project to find methods of eradicating schistosomiasis.

Meetings and Elections

The United Nations announces that arrangements for reserved seating space at its **Scientific Conference on the Conservation and Utilization of Resources** (see *Science* April 29, page 452) will be made for those who request such reservations in advance of the conference, August 17–September 6. The meetings will be open to the public, and attendance of scientists and other technical experts interested in resource use and development is particularly welcome. Those interested should write directly to the United Nations, Lake Success, New York, addressing letters to the attention of Alfred J. Van Tassel, Executive Secretary, UNSCCUR. If seating space is available, it will be possible to make reservations by telephone one day in advance, up to the last day of the conference. Calls should be made to D. J. Walsh, UN Admissions Officer, Fieldstone 7-1100, Extension 2126 or 2156. Not more than two reservations can be made by a telephone call.

The Meteoritical Society will hold its twelfth annual meeting September 6–7, at the University of Southern California, Los Angeles. Chairman of the program committee is John A. Russell, Department of Astronomy, University of Southern California, Los Angeles 7.

The fourth meeting of the **Conference on Low Temperature Calorimetry** will be held at the Massachusetts Institute of Technology on September 10 in conjunction with the **International Conference on the Physics of Very Low Temperatures**, scheduled September 6–10. Further details can be supplied by J. C. Slater, Department of Physics, M. I. T., Cambridge, Massachusetts.

The summer meeting of the **Northeastern Division, American Phytopathological Society** will consist of a tour through various parts of New Jersey September 8–9. Diseases of various crops will be studied in the field, particularly those crops unique to New Jersey or occurring on a large scale in that state.

The Ninth International Congress of Psychotechnology will meet in Berne, Switzerland, on September 12–17, with Henri Piéron as president. Psychologists wishing to send exhibits of charts, tests, or recent books for display should correspond with Harold Seashore, 522 Fifth Avenue, New York 18. For information regarding the congress and for registration, write to Mme. Dr. Franziska Baumgarten, Thunstrasse 35, Berne, Switzerland.

The Illuminating Engineering Society will hold its national technical conference September 19–23 at French Lick, Indiana. A review of lighting achievements of the past year will comprise the program.

A conference on elementary particles will be held in the Department of Natural Philosophy, University of Edinburgh, November 14–16. Further information will be obtainable about the end of August from A. Nisbet, Department of Mathematical Physics, University of Edinburgh, Drummond Street, Edinburgh 8.

The Union Americana de Medicina del Trabajo (American Union of Occupational Medicine), composed of specialized medical societies of 17 American republics, will hold its first congress in Buenos Aires in December. José Pedro Roggi, professor of the Faculty of Medical Science of Buenos Aires, is director general of the union. Its official publication, *Medicina del Deporte y del Trabajo*, is printed in Spanish, English, and Portuguese. Further information regarding the congress may be obtained from the General Secretary, Arenales 981, T. E. 42, Callao 1015, Buenos Aires.

At the 15th annual meeting of the **American Malacological Union** held at the University of Miami, Florida, June 16–18, the following officers were elected: president, Fritz Haas, Chicago Museum of Natural History; vice president, Joseph P. E. Morrison, Smithsonian Institution; second vice president, John Q. Burch, Los Angeles; treasurer, Harold R. Robertson, Buffalo; secretary, Mrs. Harold R. Robertson, Buffalo Museum of Science.

The Pacific Division of the American Malacological Union held its second annual meeting in Long Beach, California, June 10–12. Officers elected were chairman, John Q. Burch, Los Angeles; vice chairman, Leo G. Hertlein, California Academy of Sciences; secretary-treasurer, Wendell O. Gregg, Los Angeles.

The American Institute of Electrical Engineers elected the following new officers at its annual meeting held June 22: president, James F. Fairman, vice president of the Consolidated Edison Company of New York, Inc.; vice presidents, C. G. Veinott, Lima, Ohio; W. J. Seeley, Durham, North Carolina; W. C. DuVall, Boulder, Colorado; Ralph A. Hopkins, Los Angeles, California; A. H. Frampton, St. Catherines, Ontario, Canada. W. I. Slichter, of New York City, was reelected treasurer.

The Oak Ridge Institute of Nuclear Studies named the following officers at its board of directors' meeting on June 28: president, Paul M. Gross, vice president, dean of the graduate school, and professor of chemistry at Duke University; vice president, J. W. Beams, director of the School of Physics at the University of Virginia; chairman of the 24-man council of the institute, J. Harris Purks, Jr., professor of physics at Emory University on leave as director of the University Center in Georgia; vice chairman of the council, L. A. Pardue, dean of the Graduate School of the University of Kentucky. All of the officials elected retain their university positions and duties.

The council also elected five new universities to membership in the institute. They are Mississippi State College, North Carolina State College, Rice Institute, Virginia Polytechnic Institute, and the University of Oklahoma.

The American Psychiatric Association named the following officers at its 105th annual meeting in Montreal: George S. Stevenson, medical director of the National Committee for Mental Hygiene, New York City, president; John C. Whitehorn, professor of psychiatry, Johns Hopkins University, president-elect; Leo H. Bartemeir, Detroit, secretary; and Howard W. Potter, William Alanson White Clinic, Brooklyn, New York, treasurer.

The Alabama Academy of Science has elected the following officers for the ensuing year: president, C. A. Basore, Alabama Polytechnic Institute, Auburn; president-elect, H. E. Wilcox, Birmingham Southern College; secretary-treasurer, William T. Wilks, Troy State Teachers College, Troy; and councilor of the AAAS, Katherine Vickery, Alabama College, Montevallo.

The American Society of Plant Physiologists has elected the following officers for the year beginning July 1: president, James Bonner, California Institute of Technology; vice president, C. H. Wadleigh, U. S. Regional Salinity Laboratory; and secretary, T. C. Broyer, University of California at Berkeley.

NRC News

The National Research Council has announced the award of 19 fellowships in the medical sciences. These fellowships are supported by an appropriation of the Rockefeller Foundation and are designed to give special facilities for training and experience in research to recent graduates who are not yet professionally established, but who wish to devote themselves to an investigative career in the medical sciences. The 12 new fellows for the year 1949–50, the institutions at which they will receive their training, and the subjects of their research are: *Henry T. Bahnson*, University of Rochester, cardiorespiratory physiology; *Harold W. Baker*, Vanderbilt University, bile acid concentration in serum and ability of the liver to conjugate bile salt administered in the unconjugated form in health and in liver disease; the effect of cystine, methionine, and choline on damaged livers; *Richard J. Cross*, Public Health Research Institute of the City of New York, intermediary metabolism in laboratory animals; *Marion E. Lahey*, University of Utah, the pathogenesis of the anemia of infections; *Alexander Leaf*, Massachusetts General Hospital, the renal control of sodium excretion in the edematous subject with cardiac or kidney disease; *Lionel Manson*, Western Reserve University, biosynthesis and breakdown of pentose and desoxypentose nucleosides in microorganisms; *John B. Neilands*, Karolinska Institute, Stockholm, Sweden, enzymes and intermediary metabolism; *Arnold S. Relman*, Evans Memorial Hospital, Boston, relation of renal hemodynamics to electrolyte excretion; *Alexander Rich*, California Institute of Technology, characterization of proteins by physical methods; *Martin P. Schulman*, University of Pennsylvania, isolation of the individual enzymes and cofactors concerned with the synthesis of tissue proteins; *W. Eugene Stern*, Johns Hopkins Hospital, neurophysiological studies in cerebral circulation in primates; and *John M. Weller*, Harvard Medical School, factors affecting the rate of exchange of potassium between the intracellular phases and the metabolic processes which maintain the potassium gradient. The board has renewed seven fellowships for a second year.

The Rockefeller Foundation has also provided the Research Council with funds in support of the **Welch Fellowships in Internal Medicine.** These fellowships are of senior grade, and are intended to provide a prolonged period of advanced training for individuals of proven ability in research. Two new fellows were appointed: *Irving M. London,* for the term 1949–52 at Columbia University, for research in forphyrin metabolism; and *Charles R. Park,* for the term 1949–52 at Washington University, for research in hormonal influences on the hexokinase reaction in muscle. Two other fellowships were renewed.

The National Foundation for Infantile Paralysis, Inc., has made available a grant in support of **research fellowships in fields related to infantile paralysis.** Under this appropriation, fellowships are offered to provide opportunities for training and research in those basic medical sciences which will be of particular value in furthering progress in the field of orthopedic surgery; a second group of fellowships is available for special experience in the study of virus diseases. The following new fellows were appointed for training during 1949–50 at the institutions and in the fields named: *Thomas D. Brower,* University of Chicago Clinics, effects of age and disease on the morphological and biochemical changes in cartilage; *Thomas T. Crocker,* Yale University, purification and study of elementary bodies of the virus of meningopneumonitis; and *Eugene R. Mindell,* University of Chicago Clinics, chondrodystrophies. **Senior fellowships in the fields of clinical neurology, epidemiology, orthopedic surgery, pediatrics, and virus diseases** are also offered under this grant. These senior fellowships are open to men and women who have already shown definite achievement in research. Those appointed in 1949, their terms, training institutions, and subjects are: *Edward H. Ahrens, Jr.,* 1949–50, Rockefeller Institute for Medical Research, New York City, chemical studies of the serum phospholipids and the protein-bound fatty acids; *Calderon Howe,* 1949–51, Harvard Medical School, physical-chemical characterization of the red cell protein, with particular reference to various antigenic or receptor components; *Edward H. Kass,* 1949–52, Thorndike Memorial Laboratory, Boston City Hospital, (1) the cultivation of strains of poliomyelitis virus on tissue culture media, (2) isolation and purification of selected viruses of different immunologic behavior, and (3) disturbance in electrolyte patterns in patients with proven severe viral infection; *Paul S. Rubin,* 1949–50, Johns Hopkins Hospital, mechanisms of calcification; *Charles W. Watson,* 1949–52, Boston City Hospital and Harvard Medical School, relationship between frontal cortex and the thalamus of man; and *Clark D. West,* 1949–50, University of Cincinnati, (1) calculation of proximal and distal tubular osmotic work of the normal kidney during osmotic diuresis, (2) renal insufficiency during dehydration in experimental animals, and (3) osmotic limitations of the nephritic kidney. Five other fellows will work during the coming year under appointments granted in previous years or under renewed appointments made in 1949.

CARE's program to replenish the war-damaged libraries of Europe and the Far East with English-language books (see *Science,* May 6, page 476) will begin this month. A preliminary list of 1,200 titles has been selected by a committee, headed by Luther Evans, Librarian of Congress. The present categories include health and welfare, medicine, dentistry, applied science, nursing, agricultural science, veterinary science, and English language instruction. Additional categories may be included later. The books will be delivered abroad at the publishers' list price with no extra charge for transportation or distribution. Only new books will be sent.

In addition to Dr. Evans, the committee members are John M. Cory, executive secretary, American Library Association; Alice Dulany Ball, executive director, United States Book Exchange; John F. Fulton, Sterling professor, Yale Medical School; and R. R. Hawkins, chief of the Science and Technology Division, New York Public Library.

Contributions may be sent to CARE Book Program, CARE, 20 Broad Street, New York 5. Donors of $10 or more may specify country, type of institution, and category of books, although CARE hopes that the majority of contributions will be undesignated.

A new bimonthly periodical, *Iodine Abstracts and Reviews,* is being prepared by the Iodine Fellowship at Mellon Institute, Pittsburgh, to provide summaries of scientific and technical literature relating to the uses of iodine and its compounds in chemistry and in the industries. From time to time there will be presented reviews of specific phases of the science and technology of iodine. Complimentary subscriptions may be secured by addressing the Iodine Educational Bureau, Inc., 120 Broadway, New York 5.

Make Plans for—

United Nations Scientific Conference on the Conservation and Utilization of Resources, three-week session beginning August 17, Lake Success, New York.

Pennsylvania Academy of Science, August 19–20, Stroudsburg and Buck Hill Falls, Pennsylvania.

1949 Plant Science Seminar, August 21–27, University of Wisconsin School of Pharmacy, Madison.

Symposium on Modern Physics, August 22–September 2, Oak Ridge, Tennessee.

American Institute of Electrical Engineers, Pacific general meeting, August 23–26, Fairmont Hotel, San Francisco, California.

2nd International Biometric Conference, August 30–September 2, University of Geneva, Switzerland.

International Union of Chemistry, 15th conference, September 6–10, Amsterdam, Holland.

Domestic and Foreign Periodicals in the Field of Organic Chemistry: A Statistical Analysis

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AS PART of a comprehensive study of periodicals in the field of chemistry, a survey was made to determine the leading domestic and foreign journals in the field of organic chemistry, the relative importance of the journals, the countries of publication, and the languages of publication. Other articles have already been published on this study (*1–4*). The data collected may be used to answer various questions about the literature of organic chemistry, especially as affected by World War II, and questions about the decline in the use of German as a scientific language, and the position of Russian as a scientific language.

Data for the study were obtained from the organic chemistry section of *Chemical Abstracts* (*5*), since it was thought that the number of articles abstracted in this publication should give a good measure of the relative importance of a chemical periodical. Two complete years were taken for the study—1937, a depression and prewar year, and 1947, a postwar year—as representative of the change over the past ten years. The information taken from *Chemical Abstracts* included name and country of the source journal, language of publication of the article, and total number of articles for each journal, country, and language. *The List of Periodicals* (*7*) was consulted as an aid in determining the country and language of individual periodicals. The language of the original article is stated in the abstract for work taken from polylingual journals. The data obtained are here arranged in three tables, by journal, country, and language.

Analysis of Table 1 reveals that *Journal of the American Chemical Society* is far out in front as the leading journal of organic chemistry for 1947, after having shared the honor in 1937 with the German *Berichte*, according to the figures. *The Journal of the Chemical Society* of London has had fewer articles abstracted as compared with 1937, but, because of the fate of *Berichte*, has moved into second place in world importance, though considerably behind the American journal. The third ranking journal from the standpoint of number of articles abstracted in 1947 is *The Journal of the Chemical Society of Japan*. This is misleading, however, as the articles abstracted in 1947 represent a coverage of six years from 1941–'46. Journals showing an increase in number of articles abstracted in 1947 over 1937 are: *Helvetica Chimica Acta* of Switzerland, *Comptes Rendus* of France, *Journal of Organic Chemistry*, and *Industrial and Engineering Chemistry* of the United States. As for the opposite side of the picture, *Berichte* and *Annalen* show a tremendous decrease in articles abstracted. Russia's *Journal of General Chemistry* and Italy's *Gazzetta Chimica Italiana* also showed a loss and Japan's *Journal of the Pharmaceutical Society* dropped out of the 1947 *Chemical Abstracts* entirely.

TABLE 1

ABSTRACTS BY JOURNAL

Journal	Country	1947		1937	
		No.	Rank	No.	Rank
J. Amer. chem. Soc.	U. S.	682	1	337	1 (tie)
J. chem. Soc., Lond.	England	254	2	307	3
J. chem. Soc. Japan	Japan	210*	3	29	21
Helvetica Chimica Acta	Switz.	190	4	98	7
J. gen. Chem.	USSR	170	5	213	4
C. R. Acad. Sci.	France	151	6	118	5
J. org. Chem.	U. S.	149	7	49	12
Bull. Soc. Chim.	France	81	8	83	9
Bull. chem. Soc. Japan	Japan	75	9	30	19
Ind. eng. Chem.	U. S.	63	10	10	..
Rec. trav. chim.	Holland	56	11	56	12
Gaz. Chim. Ital.	Italy	50	12	100	6
Nature, Lond.	England	41	13	19	..
J. biol. Chem.	U. S.	36	14	46	13
Ber.	Germany	15	..	337	1 (tie)
Ann.	Germany	3	..	88	8
J. pharm. Soc. Japan	Japan	0	..	71	10
Total abstracts		2961		3048	
Total journals			205		222

* Data covers a span of six years.

Analysis of Table 2, summarizing abstracts by country of publication, shows again that the United States is far out in front, with three times the output of its nearest competitor, Britain, having taken over first place, probably permanently, from Germany. Britain has remained stable in number of abstracts, but, because of the collapse of Germany and Russia, has gone from fourth to second place. Germany has gone from first to tenth, with an output only 10 percent of the 1937 figure, while Russia has dropped from third to fifth having an output of only 60 percent of the 1937 figure. France has already staged a comeback from the effects of the war, showing a gain from fifth to fourth and a slight gain in total output. Other countries showing a gain in output are: Switzerland (which has doubled its 1937 output), Sweden, Spain (which shows increases in other fields as well as organic chemistry), Finland, and Canada. Japan shows a large increase, owing to the fact that the 1947 abstracts include a six-year coverage. Large decreases are shown by Germany, Russia, Italy, and India. Effects of the war explain all but the case of India. A smaller decrease is shown by Austria.

TABLE 2

ABSTRACTS BY COUNTRY

Country	1947			1937		
	No.	Rank	%	No.	Rank	%
United States ..	1057	1	35.6	524	2	17.1
British Isles ...	374	2	12.6	369	4	12.0
Japan	329*	3	11.1	205	6	6.7
France	267	4	9.0	232	5	7.5
Russia	250	5	8.4	432	3	14.1
Switzerland	204	6	6.9	99	9	3.2
Italy	76	7	2.5	156	7	5.1
India	74	8	2.5	103	8	3.4
Netherlands	62	9	2.1	67	10	2.2
Germany	57	10	1.9	611	1	19.9
Sweden	39	11	1.3	15	17	0.5
Spain	36	12	1.2	7	22	0.2
Finland	32	13	1.1	15	18	0.5
Canada	20	14	0.7	12	19	0.4
Austria	12	15	0.4	19	14	0.6
Totals	2961			3068		

* 1947 abstracts cover six-year period (1941–6).

Analysis of Table 3, summarizing abstracts by language of publication, shows an increase in the number of articles published in the English language—57.1 percent in 1947 and only 36 percent in 1937. This follows from the increase in United States and British articles and from the fact that some foreign journals are polylingual, one of the languages usually being English. Abstracts of articles in the French language have increased slightly and French is now the leading foreign language, having displaced German and Russian in the past ten years. German is now the second most important foreign language and Russian has decreased by half of the 1937 figure, now being the fourth most important foreign language, if we count Japanese as third. Russian will no doubt recover, but there is room for doubt in the case of German. Languages which have shown a gain in importance in the past ten years are: English, French, Spanish, and Finnish. The increase in the number of Spanish language abstracts is due to increased activity in Spain itself rather than in Spanish-speaking countries, which is evident from checking Tables 1 and 2. Both Italian and Dutch have decreased in importance by half in the past ten years, obviously having been affected by the war.

TABLE 3

ABSTRACTS BY LANGUAGE

Languages	1947			1937		
	No.	Rank	%	No.	Rank	%
English	1691	1	57.1	1098	1	36.0
French	339	2	11.4	301	4	9.9
German	305	3	10.3	773	2	25.4
Japanese	238*	4	8.0	171	5	5.6
Russian	222	5	7.5	395	3	12.9
Italian	76	6	2.6	156	6	5.1
Spanish	48	7	1.6	17	10	0.6
Finnish	11	8	0.4	2	..	...
Dutch	10	9	0.3	24	8	0.8
Swedish	8	10	0.3	8	13	0.3
Totals	2961			3048		

* Abstracts cover six years (1941–6).

It is interesting to compare these results with a somewhat similar study made by Gross (*6*) some twenty years ago. Although the data was collected in a different manner, an examination of this previous study will at least show the trend in importance of the journals and languages in the past twenty years. It indicates that in that time English has forged ahead as the leading language of science, putting German and French into the background. Also, Russian was of very slight importance twenty years ago but is now a serious contender for honors as the leading foreign language. Another item of note is that, whereas the German *Berichte* and *Annalen* were formerly leading journals, they have now lost some of their former importance, and on the other hand, such important journals of twenty years ago as *Journal of the Chemical Society* of London, *Comptes Rendus*, *Bulletin de la Societe Chimique* of France, *Industrial and Engineering Chemistry*, and *Gazzetta Chimica Italiana* are holding their own today.

The present study indicates that the *Journal of the American Chemical Society* is the leading world journal in the field of organic chemistry, with the *Journal of the Chemical Society* of London, *Helvetica Chimica Acta* of Switzerland, *Journal of General Chemistry* (USSR), and *Comptes Rendus* of France following in that order. Missing from the more important journals are *Berichte* and *Annalen,* which in 1937 were in the first and the eighth place, respectively.

Among countries of publication, the United States has a comfortable lead, with Britain, France, Russia, and Switzerland following in that order. Germany has lost considerable ground, as has Italy, and Russia has lost a little ground. Sweden and Switzerland have increased in importance.

Fifty-seven percent of all articles published are now in English. French, German, Russian, and Italian, in that order, account for the remainder. The last three languages mentioned have lost ground, whereas French shows a slight gain over 1937.

Japanese periodicals, contributions, and language are placed high on the respective lists, but this is misleading, since the figures cover a six-year range.

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Production of Radioactive Mosquitoes[1]

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A RELIABLE METHOD of marking and detecting insects is greatly desired in ecological studies of certain medically and economically important species. In regions where pest mosquitoes are abundant, as in the arctic and subarctic, data on the range of dispersal and migration are needed to guide insecticidal control operations

A method has been developed for producing readily detectable radioactive mosquitoes by rearing the yellow fever mosquito *Aëdes aegypti* in beakers of distilled water containing radioactive material. The larvae were fed ground dog-biscuit, using the standard rearing techniques.

Radioactive phosphorus (P^{32}) was selected for the experiments because of its convenient half-life (14.3 days) and lack of either persistent radiation or toxic disintegration products. Its strong beta radiation permits ready detection with most of the equipment in use, and the lack of alpha or gamma radiation makes its use safer. Phosphorus was also judged to be an element which would be readily taken up and retained by the organism.

The activities of mosquitoes, larvae, and solutions were measured in an Autoscaler. The background count of 25 cpm has been deducted from all data in the tables, and all counts over 1000 cpm have been corrected by adding the factor $\left(\frac{\text{cpm}}{1000}\right)^2 \times 5$.

In order to ascertain the optimum concentration and exposure time, the following experiments were performed.

A. Second instar larvae were reared in five solutions of $Na_2HP^{32}O_4$ ranging in strength from 0.05 to 10 μc/ml. All the larvae were greatly retarded in rate of development, and at high concentrations pupation did not occur for over 20 days. At a concentration of 1 μc/ml adults emerged after 15 days and were found to vary in activity from 6,761 to 10,132 cpm.

B. Third and early fourth instar larvae were put into a solution containing 10 μc/ml. They developed normally and adults began to emerge on the sixth day thereafter. The activity of each mosquito was measured on the day of emergence, and the resulting data are given in Table 1. On the tenth day the activity of the solution was measured and found to have decreased to 0.4 μc/ml.

TABLE 1

Activity Measurements of Adult Mosquitoes from Exposed Third Instar Larvae

Days of exposure	No. of adults	Cpm of individual adult mosquitoes		
		minimum	maximum	average
6	12	2,663	132,405	36,215
7	5	7,534	32,143	18,881
8	7	6,036	37,863	29,138
9	5	30,952	39,918	37,176
10	12	4,484	32,860	27,778

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[1] A similar article dealing with radiophosphorus and radiostrontium in mosquitoes by John C. Bugher and Majorie Taylor will be published in next weeks issue.

C. Pupae approximately one day old were put into solutions containing 10 μc/ml. Adults emerging 24 to 48 hours later were examined and found to average only 30 cpm above background. Newly formed pupae kept for three days in an identical solution absorbed slightly more phosphorus; ten emerging adults averaged 80 cpm with a range of 40 to 107 cpm.

TABLE 2

ACTIVITY MEASUREMENTS OF WASHED LARVAE AND PUPAE AND UNCONTAMINATED ADULTS

Stage	Number counted	Cpm/individual		
		minimum	maximum	average
Fourth instar larvae	7	13,304	16,876	14,076
Pupae	6	16,878	30,952	26,230
Adults	12	4,484	82,860	27,778

D. In order to ascertain whether the radioactivity found was the result of an actual accumulation of P^{32} by the larvae, or of contamination of the emerging adults by the rearing medium, third instar larvae were put into a solution containing 10 μc/ml. Eight days later, pupae and fourth instar larvae were removed and washed ten times in distilled water. After an additional 24 hours in distilled water, some were removed and examined. Adults emerging from the washed pupae were also examined. All proved to be highly radioactive, as shown in Table 2. A sample of the water from which these specimens were removed had an activity of 212 cpm/ml.

Calibrations of the counting equipment in our laboratory have shown that a rate of 5×10^5 cpm is the equivalent of 1 μc of P^{32}. It can therefore be calculated from the data of Table 2 that the average accumulation of P^{32} by individuals examined as larvae was 0.03 μc in 8 days, while the resulting pupae and adults contained nearly twice as much. Calculations from Table 1 show that much higher accumulations may occur, the highest recorded being about 0.25 μc. Using a generally accepted figure (*1*) for converting curies to grams, one finds that the above values represent 1×10^{-11} and 8.7×10^{-11} g P^{32}.

Additional experiments are in progress to ascertain the minimum quantities of radiophosphorus which can be used, to elucidate further the effects of radiation on development, and explain the wide variation in the accumulation of P^{32} shown by the data in hand.

Highly radioactive mosquitoes can be produced. Larvae accumulate large amounts of P^{32}, but pupae accumulate relatively little. The radioactivity thus produced is not lost rapidly either by adult mosquitoes or by larvae and pupae transferred to a nonradioactive medium.

The method described offers a convenient way of producing marked mosquitoes for studies of dispersal and predation. Valuable data on metabolic activities of mosquitoes, the effects of beta radiation on insects, etc., may be expected from further studies.

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Neil Elbridge Gordon: 1886–1949

George Calingaert

Ethyl Corporation

My most vivid recollection about Neil Gordon is that of a wintry afternoon in the mid-thirties, when I noticed from the window of my laboratory a man with a large umbrella, an unannounced visitor approaching our lonely building with a slow but purposeful gait, paying no attention to the wind and rain which seemed determined to hamper his progress. Dr. Gordon was on that day bent on one of those missions which endeared him to all who have seen him at work: enlisting interest and cooperation for one of his projects in support of chemical progress. And as the years went by I learned how characteristic that picture was of the man.

Chemical research and the teaching of chemistry have always been the twin interests of Dr. Gordon: after obtaining his Ph.D. from Johns Hopkins University in 1917 he taught successively at his alma mater, the University of Maryland, and at Central College in Missouri and Wayne University in Michigan. His numerous publications reveal his parallel interests in the problems of teaching and in several fields of research, principally in adsorption, colloids, emulsions, and dyeing. His interest in chemists as individuals was as keen as his interest in their work, and many a young instructor or professor still remembers the help and inspiration he received from

Dr. Gordon in his first attempts at embarking upon original research. Dr. Gordon also demonstrated repeatedly his ability as an organizer, and as head of the Chemistry Department at Wayne University he succeeded in a very short time in giving new impetus to the work of the Department, and in expanding its scope to include the training of Ph.D.'s.

But in addition to a career which would have taken all the time of an ordinary man, Neil Gordon always seemed to be fired by a novel idea, to want to develop a different—and often an unorthodox—way of speeding up the wheels of chemical progress. In rapid succession he thought up these new ideas and pursued them with dogged determination, often against the resistance of the timorous, but he seldom failed to secure adequate support from those who admired him for his originality and resolution, and who instinctively trusted him because he was always giving so unsparingly of his own means and energy. In this manner he conceived, created and managed in succession:

1924—the *Journal of Chemical Education*,
1929—the National Research Fellowship Program at Johns Hopkins University,
1938—the Gibson Island Conferences of the AAAS, and
1936—the Hooker Library, which in 1942 became the Kresge-Hooker Library.

The Gibson Island Conferences were operated under the sponsorship of Section C, of which Dr. Gordon was long the secretary, and in 1948 the conferences were fittingly renamed Gordon Research Conferences. As the scroll delivered to him on that occasion states:

> Dr. Gordon has introduced a new and fruitful means for the exchange and advancement of knowledge through informal meetings held in pleasant, healthy, and friendly surroundings. His faith in his ideas and his indefatigable efforts in bringing them to pass have brought lasting benefits to the science of chemistry.

The progress of science would be slow indeed without the support of such men of vision, character, and determination. We must thank our lucky stars when one shows up, and at the same time thank ourselves for our freedoms which give the individual with an original idea the opportunity to bring it into full realization if, like Neil Gordon, he has the faith and energy to do it.

William Townsend Porter: 1862–1949

A. J. Carlson

University of Chicago

W. T. Porter was born in Plymouth, Ohio, in 1862 and received his medical training and his M.D. degree at the St. Louis Medical College in 1885. He served as acting superintendent of the St. Louis City hospital for one year, and as assistant professor and professor of physiology at the St. Louis Medical College from 1887 to 1893. During these years Dr. Porter also pursued graduate studies in Germany—Berlin, Breslau, Kiel. He was elected a member of the American Physiological Society at its fourth annual meeting in 1891. At that time probably no one could have predicted the outstanding service Dr. Porter was to render to American physiology during the following sixty years.

Dr. Porter became a member of the faculty of Harvard University Medical School in 1893, and continued a member of that faculty until his retirement in 1928. His teaching of physiology at the Harvard Medical School led him to establish the Harvard Apparatus Company, for the production of better and less expensive laboratory apparatus for both teaching and research in physiology. His work on the coronary circulation of mammals is probably his most fundamental research contribution to biology and medicine, but in his earlier years he also worked and published on growth, respiration, the nervous system, and skeletal muscle.

When Dr. Porter joined the faculty of the Harvard University Medical School physiology was taught to medical students largely by "talks and books." Fifty years later he wrote: "It was easy to say that physiology should be taught by experiments performed by the students themselves. But in 1899 the Harvard Medical School had 200 students in physiology. Working in pairs these students needed 100 kymographs. At that time this apparatus was made only in Europe, and could be imported at the cost of $200 apiece. Obviously even the richest university medical school could not meet this teaching requirement at such costs."

Dr. Porter started to meet these essential requirements for medical training by simplifying existing laboratory equipment, inventing new apparatus, and reducing costs by quantity production, at first using the mechanical facilities of the Harvard Medical School. Very soon other medical schools wanted this laboratory equipment, but Harvard University could not sell it. This led Dr. Porter, aided financially by President Eliot, three men on the Harvard Medical School faculty, and two more citizens of public spirit in Boston to establish the Harvard Apparatus Company as a nonprofit educational institution. This company has been a large factor in providing, at low cost, equipment for research and teaching in physiology and pharmacology, not only in the United States, but in many other countries. Dr. Porter was the active head and guide of the Harvard Apparatus Company until a few months before his death. He conducted the business in the public interest and without commercial profit. When there was a modest surplus, this was used to improve production equipment, to provide a pension fund for the company's employees, and to finance the W. T. Porter Research Fellowship in Physiology, administered by the Council of the American Physiological Society. In 28 years (1921–49) the Harvard Apparatus Company has contributed a total of $38,453.00 to the American Physiological Society for the Porter Fellowship in Physiological Research. Dr. Porter twice offered to give his Apparatus Company to the Physiological Society.

The significant attention to physiological research in our country towards the close of the last century raised the question of adequate facilities for publication. In 1894 Dr. Porter was made a member of a committee to investigate ways and means to start an *American Journal of Physiology* by the then young physiological society. The society did not accept the committee's recommendations that such a journal be started. But in 1897 Dr. Porter started the *American Journal of Physiology*, as the sole responsible editor and publisher, and carried these financial and intellectual burdens until 1914, when 34 volumes of the journal had been published. In that year Dr. Porter presented the *Journal* (including all unsold numbers) to the American Physiological Society. In recognition of this great service to American physiology the society dedicated Volume 37 to him. The dedication includes this significant statement, referring to his services as editor: "A rigid pursuit of ideals by one individual frequently arouses in others lack of appreciation, criticisms, and opposition; and these he received without complaint."

In consideration of all the significant services of Dr. Porter—the early years of the *Journal*, the Harvard Apparatus Company, the Porter Fellowship—the society made him honorary president for its 50th anniversary meeting in Baltimore in 1937, and in 1948 elected him honorary life member. Referring to those early and trying years, the late W. H. Howell of Johns Hopkins Medical School said in 1938: "The American Physiological Society never gave the *American Journal of Physiology* the financial support that might properly have been expected." Dr. Porter's contributions were achieved by his integrity, his courage, and his intelligence rather than by his financial fortune. Knowing Dr. Porter, a few of his colleagues in the medical school and other citizens in Boston gave him some initial financial aid both for the *Journal* and for the Apparatus Company. But the main financial burden for both was carried by Dr. Porter. I have never heard anything but praise for the services of the Harvard Apparatus Company.

Dr. Porter's record as editor of the *Journal* is to his great credit, but even a superior editor is not a superman. There were more than a few of the younger investigators who did not take kindly to Dr. Porter's analysis, criticisms, and suggestions of their research reports submitted for publication in the first 34 volumes of the *American Journal of Physiology*. His editorial policy may be illustrated by his reply to me when I sent him in 1904, my first study on the limulus heart for publication in the *Journal of Physiology*. He wrote: "I think you are wrong both in your observations and your interpretations, but I will publish your report in the *Journal*."

The record of Dr. Porter's unselfish and significant services to his generation is a true picture of the man, as I knew him for nearly fifty years. In these times of well-nigh pandemic hysteria, hate, and fear, William Townsend Porter's persistent and serene work for his fellow man aids our courage for today and guides our hope for tomorrow. May his tribe increase!

TECHNICAL PAPERS

Factors in Neonatal Resistance to Anoxia. I. Temperature and Survival of Newborn Guinea Pigs Under Anoxia[1]

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It is standard hospital procedure to place anoxic babies in a warmed bassinet or incubator and give them oxygen. Since the speed of chemical reactions of importance to life is, according to Van 't Hoff 's rule, doubled or trebled with each 10° C rise in temperature, some doubts appeared in the mind of the writer as to the advisability of warming the anoxic child. Accordingly, an investigation of the effects of temperature upon survival of anoxic newborn animals was undertaken.

This short preliminary account of results of this investigation is being presented at this time in the hope that it may stimulate clinical studies on the treatment of asphyxiated newborn infants.

The experiments were performed as follows: Littermate guinea pigs 24 hr old or less were used. Temperatures were taken by using a U. M. A. skin thermocouple with the sensitive element modified so that it could be used as a small colonic thermometer. Each reading was taken with the element inserted into the anus for a distance of 20 mm. Temperatures were taken immediately before and after the experiment.

The temperature differentials were produced as follows: In litters of three or more, one animal was left untreated, one was incubated for ½ hr, and one or more was cooled. In litters of two, one was cooled or warmed, the other left untreated.

The colonic temperatures of the untreated animals usually varied between 29° and 33° C. This is an example of the well-known fact that the temperature-regulating mechanism is either very inefficient or nonfunctional in neonatal mammals.

Cooling was produced by wetting all but the head and circumanal region with 95% alcohol and exposing the animal to air currents from a 12-in. electric fan. When its temperature had fallen 2° to 5° C it was placed with a littermate under a glass bell jar with a current of 95% N_2 and 5% CO_2 flowing through. Records were kept of the time of appearance of all visible reactions, timed by means of a stop watch.

In a preliminary series of experiments the animals were exposed to anoxia for 4¼ min (4 experiments, 10 animals) or 4¾ min (4 experiments, 14 animals) and then removed. This length of exposure was sufficient to kill the warmed and the room temperature animals and, with but one exception, their cooled littermates recovered from the treatment. The exceptional animal withstood 4¾ min of exposure but succumbed 52 sec after removal of the bell jar.

Next, experiments were performed in which the animals were exposed until dead. The time of appearance of the last slight movement of the abdominal wall in an attempt to gasp was recorded as the time of death (T.O.D.). Preliminary experiments had established that, even though spontaneous recovery may occur if the bell jar is removed before the last few weak and ineffective gasps, it does not happen when the animals are exposed to the gas mixture until gasping has stopped completely.

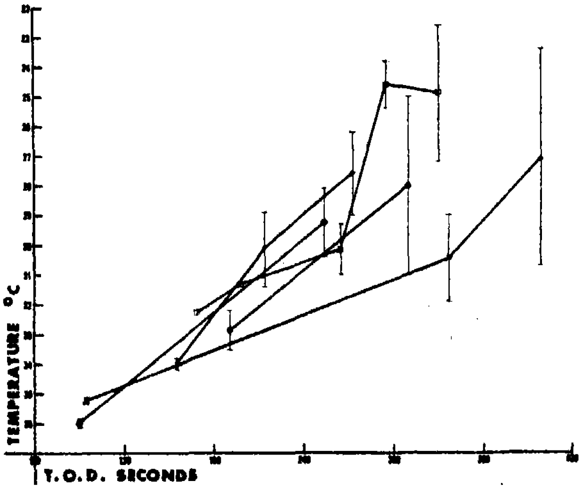

FIG. 1. Five typical experiments showing the effects of temperature on time of death (T.O.D.) of day-old guinea pigs exposed to 95% N_2 and 5% CO_2 until dead.

Fig. 1 is a graph of 5 experiments with a total of 15 animals, giving a typical picture of the effect of temperature on the survival of day-old guinea pigs. On the abscissas are shown seconds survival, on the ordinates the temperature. Each point on the graph represents one animal, with its temperature range during the experiment indicated by the thin vertical line. The midpoint of this range is used as the temperature of the animal for purposes of calculations. Littermates are indicated by the same symbol and are connected together by a heavy line.

A glance at the graph shows that there was less variation in temperature and greater consistency in results in the case of animals kept at higher temperatures than in those kept at lower temperatures. Because the method of cooling stimulated motor activity, which might be expected to reduce the animals' potential for anaerobic survival, the cooled animals were placed in the bell jar while still wet. This reduced the total motor activity of the animal, since part of the cooling period was passed while the animal was unconscious. This procedure was instituted because in exploratory experiments the animals which were cooled for a long time exhibited both struggling and shivering. The performance of these animals in the bell jar was poorer than their uncooled littermates, and much poorer than those in which cooling took place for the most part while the animals were unconscious.

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[1] The author wishes to acknowledge with thanks support from the U.S. Public Health Service, Research Grants Division (#RG 281), which has made possible this and subsequently appearing studies on neonatal resistance to anoxia.

From these five typical experiments it appears that the effects of reduction of colonic temperatures on one-day-old guinea pigs subjected to anoxic anoxia is to prolong life at about the same rate as might be expected from Van't Hoff's rule—i.e., about three times for the first 10° C differential.

Additional experiments, confirming the findings reported here and extending them to include also nembutalized animals, will be reported later when the statistical analyses of these data are complete.

It is concluded that elevation of body temperature is deleterious to day-old guinea pigs subjected to anoxic anoxia. Reduction of temperature, at least within the limits reported here, is beneficial when cooling is accomplished with minimal motor activity and shivering.

The Genera of Amoebae

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In recent years there has been considerable discussion about the correct scientific names of certain fresh-water amoebae. The recent articles by King and Jahn (*3*) and Wilber (*5*) include references to other work on the subject.

The three species concerned are: (I) *Amoeba proteus* Leidy (*Chaos diffluens*), (II) *Chaos chaos* Schaeffer (*Pelomyxa carolinensis, Amoeba carolinensis, Chaos carolinensis*), and (III) *Pelomyxa palustris* Greeff.

The controversy embraces two separate questions: one about the relative historical validity of the generic names *Amoeba, Chaos* and *Pelomyxa.* To this question we have no contribution to make. The other question is whether (I) and (II), or (II) and (III) should be placed in the same genus, or whether they belong to three separate genera.

Since the morphological criteria seem to be insufficient to allow a clear decision of the issue, we have tried to supplement the morphological evidence with a biochemical comparison of the three organisms.

Organisms (I) and (II) are readily available and their morphology and physiology is comparatively well known. Organism (III) is, at least in Denmark, comparatively rare, and in spite of persistent search we were able to obtain only four specimens. This limited material forced us to restrict our investigation to a few characteristic properties easily determined with the micromethods at our disposal. We decided therefore to determine the contents of two proteolytic enzymes, catheptic proteinase (substrate caseinogen, pH 4.0) and peptidase (substrate alanyl-glycine, pH 7.4). In addition we measured the approximate total protein content colorimetrically by means of the Folin-Ciocalteau reagent against a tyrosine standard. Details of these methods are described in a recent publication from this laboratory (*2*). As a basis of comparison we chose the cell volume rather than weight as suggested by Zeuthen (*6*), since the cytoplasm of *Pelomyxa palustris* (III) contains a great deal of foreign inclusions, e. g., grains of sand, which could be expected to falsify the density much more than the volume.

Organism (III) was identified as *Pelomyxa* in the following way: all four specimens were examined while alive with a water immersion objective giving 40 times magnification. The sand grains coating the surface and enclosed in the cytoplasm; the broad, slowly forming pseudopodia; the vacuolar appearance; and the bacteria in the cytoplasm, were easily seen. One of the specimens was crushed between cover slips and showed numerous nuclei about 10 µ in diameter, and "glycogen bodies" to 5–30 µ in size, which varied in shape from spherical to ellipsoid, some being quite irregular. Another specimen was fixed, sectioned, and stained. The details of bacteria, nuclei, and "glycogen bodies" which are described by Leiner (*4*), were confirmed. These are the characteristic features used for determining the species *Pelomyxa palustris,* and all of them are quite different from the corresponding features in *Amoeba proteus* (I) and *Choas chaos* (II). The third specimen was used for preliminary enzyme measurements, and the last and largest animal (total volume 6.5 µl) was used for final analyses in triplicate. The calculations in Table 1 for Species (III), therefore, all refer to this one specimen but they were roughly checked by preliminary experiments which indicated the order of magnitude of enzyme activity.

The values for species (I) and (II) are averages for a great number of individuals. The values for species (III) are the means of triplicate analyses. All values refer to a standard volume of 1 µl of cytoplasm. For

TABLE 1

	Protein	Peptidase	Proteinase	Peptidase / proteinase
	µg tyrosine	0.06 N HCl/hr	arbitrary units	
Species (I) *A. proteus*	4.0	53	43	1.2*
Species (II) *Ch. chaos*	2.6	62	28	2.2*
Species (III) *Pelom. pal.*	1.0	0.31	0.25	1.2*
Ch. chaos / *A. proteus*	0.65*	1.2*	0.65*	
Ch. chaos / *Pelom. pal.*	2.6*	200*	112*	

* These figures give ratios.

species (I) this volume was calculated on the basis of Chalkley's (*1*) measurements which give an average value of 0.15×10^{-3} µl per individual. For species (II) the volume was calculated from reduced weight measurements, assuming the relation 1 µg r. w. = 50 µl volume [Zeuthen (*7*)]. The volume of species (III) was calculated from direct measurements of dimensions.

As the Table shows, in organisms (I) and (II) the magnitudes measured correspond as closely as can reasonably be expected for intimately related species. As a matter of fact, the differences fall within the range of individual variations which can be found in one species. Organism (III), on the other hand, is decidedly different from the two others, at least with regard to the content of the two enzymes. This is most clearly seen by a comparison of the ratios given in the lower half of the table.

It might be thought that the remarkably low enzyme content of species (III) is not real, but rather due to inactivation during the homogenization prior to enzyme determination. However, this would not impair the validity of our comparison, since the homogenization and enzyme determinations were carried out exactly alike in all cases. Our figures thus indicate either a difference in enzyme content or in enzyme stability. Both properties ought to be equally suitable for the purpose of species comparison.

The result of our study is thus quite unambiguous: if biochemical features are considered as valid as morphological ones, organisms (I) and (II) ought to be placed in the same genus, while organism (III) seems rather different from the two others. Since nobody questions the validity of the name *Pelomyxa palustris* for species (III), we suppose that our results would support either the generic name *Amoeba* or *Chaos* for the other two. Not being taxonomists, we venture no suggestion as to which of these it should be.

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Separation of Chloride Group Anions by Partition Chromatography on Paper

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The separation of cations by partition chromatography was described in two previous papers (*3, 4*). These separations were only possible when hydrochloric acid was added to the solvent. This prevented both hydrolysis and the existence of ions in complex and simple form at the same time. The tailing or "comet" effect of Lugg and Overell (*5*) was thus avoided.

Westall (*7*) first measured the R_f value of the Cl^- ion in several solvents and observed that the addition of NH_3 to phenol inhibited the "comet" effect and gave Cl^- ions a constant R_f value, irrespective of the accompanying cation.

Partridge (*6*), in a correction to his paper, observed that both Br^- and I^- travel at different speeds and interfered with the technique he used for the separation of sugars; but he did not give their R_f values or describe the shape of the spots obtained.

In this paper a new micromethod for the separation of Cl^-, Br^-, I^-, and CNS^- will be described. The solvent employed in the chromatograms is butanol saturated with 1·5N NH_4OH. This keeps the halides completely in the ionic form and appears to prevent any adsorption on the filter paper.

Separation is a simple matter in this method when compared with the technique required to show up the spots. After a trial of several techniques the simplest was found to be a method by which the paper was sprayed successively with two reagents and then washed and exposed to H_2S vapors.

The first method to be tried was an adaptation of that of Feigl (*2*). The silver chromate paper described there was prepared and the dried paper chromatogram was laid on top of it and sprayed with water. The halides were washed out and produced yellow spots on the red paper. This method was abandoned because the spots frequently moved on spraying with water, and also because the adsorption of halide ions on the paper might lower the sensitivity of the test.

The next method tried was spraying the chromatograms with silver nitrate solution, and then exposing to sunlight. This was found highly unsatisfactory, since a dark background formed which made the spots indistinct.

The most satisfactory method is as follows:

The paper is first sprayed with a mixture of ferric nitrate solution and hydrogen peroxide. The spraying is started from the liquid front and carried to within 4 cm of the starting point. This produces a red spot for CNS^-, R_f value = 0.42–0.48; and a blue spot for I^-, the R_f value being 0.29–0.32.

The whole of the paper is then sprayed with 0.1 N $AgNO_3$ solution, which discolors the spots originally formed and precipitates all four ions as insoluble silver salts inside the filter paper. This paper is now washed with very dilute HNO_3, so as to remove the excess of Ag^+ ions, two washes being sufficient. The paper is then held over H_2S and black AgS is formed wherever silver halides were precipitated. Chloride thus produces a brown spot (R_f = 0.1–0.11), and bromide a brown spot (R_f = 0.15–0.18).

In this paper the complete technique used will be described in detail, since a number of simplifications have been made to the method of Williams and Kirby (*8*), on which it is fundamentally based.

The aqueous phase is placed on the bottom of a 5-gal crock, where there is also a large Petri dish containing butanol. In the Petri dish is placed a measuring cylinder, fitted with a cork carrying a T-piece.

The paper is formed into a cylinder around the measuring cylinder, and supported at the top by perforating it with the arms of the ┬-piece. Narrow pieces of paper can be folded longitudinally and likewise supported. A lid is then placed on the crock to maintain a saturated atmosphere.

The development is an ascending one and the speed of the liquid front seems to decrease the farther it goes. The container was not altogether airtight, and to keep the solvent from varying in composition, it was renewed every day. In this apparatus the liquid front travels about 25 cm in 24 hr.

To prepare the solvent, 10 ml of 15 N NH_4OH was mixed with 90 ml of distilled water; this was shaken in a separating funnel with 100 ml of butanol.

The mixture separates after a very short time; the lower layer is run into the bottom of the crock and the upper layer into the Petri dish in the center of the crock.

The mixture of ammonium and potassium chlorides, bromides, iodides, and thiocyanates is concentrated or diluted so as to obtain the approximate concentration of 0.1 N. A drop of this solution is placed on the paper by dipping a thin stirring rod (2 mm diam) into the solution and then touching the paper with it about 2.5 cm away from the lower end. The adhering drop is absorbed by the paper and its position marked with pencil. The paper is then placed in the developing crock for 24 hr. Immediately on removing the chromatogram from the container, the liquid front is marked in pencil. The developed paper is dried by hanging for about 10 min in the air. This removes the ammonia and most of the butanol.

An AGLA atomizer was used for spraying reagents on the chromatograms. It produces a reasonably fine spray, but is a little too small for satisfactory use.

I^- and CNS^- travel faster than Cl^- and Br^- and can be revealed by spraying a mixture of 3% H_2O_2 and 0.1 N $Fe(NO_3)_3$ solution on the upper portion of the chromatogram. The lower 4 cm must not be sprayed with this reagent since a distortion of the Cl^- and Br^- spots may occur. The red spot of $Fe(CNS)_3$ is reasonably stable, but the blue spot of I_2 may fade in a few minutes.

The whole of the paper is then sprayed with 0.1 N $AgNo_3$ and washed twice in 0.1 N HNO_3, and the surface moisture is removed by pressing between filter papers. It is then exposed to H_2S, producing a brown spot for CNS^- and I^-, and an oblong spot of adjacent Cl^- and Br^- when both these ions are present. If only one is present a round spot is formed, which cannot be mistaken because it has different R_f measurements.

The R_f values are in reference to the liquid front, so that $R_f = \frac{\text{distance traveled by ion}}{\text{distance traveled by liquid front}}$ (*1*).

In the separation of cations two liquid fronts were noticed. This is not the case here and after drying there is little indication of the liquid front.

This new chromatographic separation of the halide groups is, in the author's opinion, highly suitable for ultimate organic analyses, since only 0.1 mg of the halide ion is sufficient to be identified.

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2,4-Dichlorophenoxyacetic Acid Inhibition of Castor Bean Lipase[1]

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The discovery of selective herbicides has aroused considerable interest in the mechanism of hormone activity. Since the growth and metabolism in the growing plant is disrupted, one might expect the enzyme systems to be affected.

Smith (*4*) showed appreciable effect on oxygen uptake of tissue slices from plants treated with 2,4-dichlorophenoxyacetic acid. One may presume that the sections of the plant functioned as entireties, and the action of the herbicide on any of the enzyme systems involved in growth and respiration would affect the observed oxygen consumption. On the other hand, we have observed no inhibition on polyphenol oxidase, α-hydroxy acid oxidase, or catalase in the presence of 2,4-D, using the tissue homogenate technique.

Preliminary studies have indicated that certain hydrolytic enzymes are affected by 2,4-D. The activity of castor bean (*Ricinus communis*) lipase was depressed by the sodium salt of 2,4-dichlorophenoxyacetic acid. The procedure used was essentially that of Longenecker and Haley (*3*). Two grams of olive oil substrate and 0.05 g of solvent-extracted castor bean meal, as the enzyme source, were weighed into 50-ml Erlenmeyer flasks. One ml of water was added to the control flasks, and 1 ml of recrystallized 2,4-D monohydrate sodium salt of the desired concentration was added to the inhibition flasks. In all cases the enzyme was activated by the addition of 0.6 ml of 0.1 N acetic acid. The flasks were incubated in a 37° C water bath. After desired reaction time, 50 ml of 95% ethyl alcohol was added to stop reaction. The degree of hydrolysis was determined by potentiometric titration of the liberated acids with NaOH to an indicated pH of 8.5. Under these conditions, slightly over half of the control substrate was utilized in a 6-hr period.

The effectiveness of the 2,4-D inhibition is of the order of 10% by 3.03×10^{-4} M. Slightly less than 70% inhibition was noted in the presence of 0.03×10^{-3} M. Harris *et al.* (*1*) have shown that sodium dichlorophenoxy acetate

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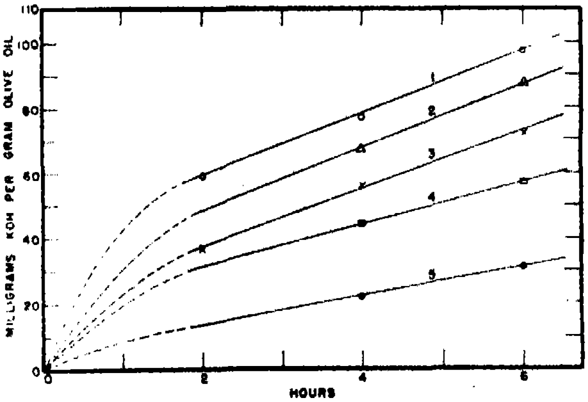

FIG. 1. 2,4-Dichlorophenoxy sodium acetate inhibition of castor bean lipase on the hydrolysis of olive oil. The curves represent varying concentration of the 2,4-D inhibitor. (1) Control, H_2O; (2) 3.03×10^{-4} M; (3) 6.05×10^{-4} M; (4) 1.52×10^{-3} M; (5) 3.03×10^{-3} M.

acts as a protein precipitant at relatively low concentration. The ether-extracted castor meal contains most of the protein originally present in the beans. Since the 2,4-D would be expected to combine with other proteins as well as the lipase, the effective concentration necessary for inactivation is probably considerably lower.

In a kinetic study of this system, conditions were followed which allowed graphical determinations as developed by Lineweaver and Burk (*2*). By varying the substrate concentration, and keeping other conditions constant, an apparent increased activation occurred upon dilution of the substrate.

2,4-D is available commercially in four chemical forms: free acid, sodium or ammonium salts, amine salts, and esters. The sodium, ammonium, and amine salts, in all probability, could be converted to the 2,4-D free acid at a rapid rate by simple dissociation, *in vivo* and *in vitro*. However, the ester conversion would be more difficult to explain by this mechanism.

The possibility of castor bean lipase acting as a typical esterase on 2,4-D esters was selected for study in an attempt to explain such a conversion mechanism. The procedure used was essentially the same as described above. The reaction flask contained 8.5 ml of solution; 0.063 M with respect to 2,4-D butyl ester, 5.7×10^{-4} M sodium oleate as an emulsifier, 5.3×10^{-3} M acetic acid as activator, and castor meal as the enzyme source. The reaction was arrested and titrated as described here.

TABLE 1

2,4-D BUTYL ESTER HYDROLYSIS BY CASTOR BEAN LIPASE, AND ULTIMATE INHIBITION OF LIPASE BY THE HYDROLYTIC PRODUCT, 2,4-D FREE ACID

Grams of castor meal	% of butyl ester converted to free acid	
	21 hr	46 hr
0.05	6.32	6.13
	5.86	....
0.10	11.15	11.43
	9.76	11.43
0.30	20.74	31.97
	32.81	31.88
0.50	48.19	52.05
	48.61	....

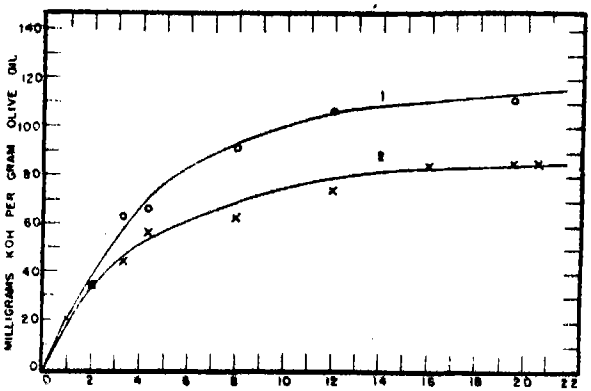

FIG. 2. 2,4-D butyl ester hydrolysis by castor bean lipase to the active 2,4-D-free acid in the presence of olive oil. Sodium oleate emulsifier added to both series of flasks. (1) Control, H_2O; (2) 0.051 M 2,4-D butyl ester.

That castor bean esterase does hydrolyze the butyl ester is indicated by the titration of liberated acid. The calculated effective concentration of 2,4-D acid product of hydrolysis, showing complete inactivation of castor bean lipase, is approximately 4.00×10^{-3} M. Thus, the 2,4-D acid approaches the same concentration, by the end of 21 hr, as shown necessary for inactivation of the lipase by the sodium salt of 2,4-D in Fig. 1.

The reaction was followed in the presence of a natural glyceride substrate. To all flasks 0.50 g of castor meal, 2.0 g olive oil, and 4.5 ml of 0.1 N acetic acid was added. The control and inhibitor series were brought to an effective concentration of 4.6×10^{-4} M sodium oleate. Butyl ester of 2,4-D was added to the inhibitor series to a concentration of 0.051 M. Total volume for all flasks was 10.5 ml. The reaction was arrested and titrated as previously described.

From Fig. 2, it becomes apparent that even in the presence of a competing substrate, the butyl ester is not effective as an inhibitor until the hydrolysis to the 2,4-D acid occurs. The time for complete inactivation of the enzyme appears to follow closely the time of inactivation shown in Table 1.

This investigation has shown that 2,4-D effectively inhibits the activity of castor bean lipase at very low concentrations. Also, through a study of the kinetics, it appears activation occurs by dilution of the substrate concentration. The butyl ester of 2,4-D has been shown to be inactive as an inhibitor for castor bean lipase, and must first be hydrolyzed to the 2,4-D acid for activity.

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A Useful Sectioning Technique

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It is often necessary to obtain sections of biological materials for microscopic examination through particular minute areas, and in rather precise positions. Often the investigator has just one cystocarp of a red alga, a single sclerotium of a fungus, or a small fragment of a valuable type specimen to section. At other times it may be desirable to section fresh aquatic (either fresh-water or marine) material without killing the cells that may remain intact, as in the examination of *Porphyra* or living leaves.

The object to be sectioned, e.g. a tooth of the fungus *Dentinum*, is placed on a microscope slide in a drop of mucilage just large enough to cover it. A specimen 0.5–1.0 mm on a side is sufficiently large, though smaller or larger pieces can be handled with ease. The mucilage should be allowed to dry until when prodded with a dissecting needle the object is motionless, as is the mucilage fracture around the needle. In general, the more nearly dry the mucilage is the better, but it must not become brittle. If the mucilage becomes too brittle that condition may be alleviated by the addition of about 10% glycerine.

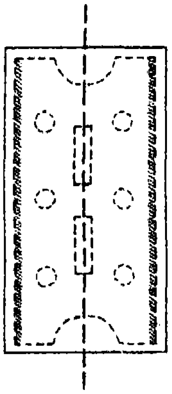

FIG. 1

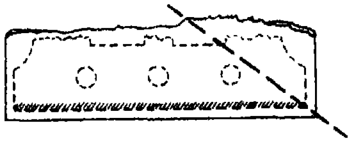

FIG 2

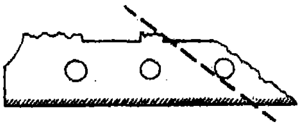

FIG 3

Double-edged razor blades are used for sectioning for several reasons: they are more readily made serviceable, and they have no stiffening edge or back that might obstruct vision or prevent resharpening as shown in Fig. 3. The blades are prepared as follows: While still in the paper package, the blade and the package are broken in half lengthwise (Fig. 1); then one end of a half-blade is broken off obliquely (Fig. 2, broken line) and the paper removed. This procedure produces a pointed blade (Fig. 5) that is very sharp. If a day or so is to elapse between sectioning, it is best to discard the unwrapped blade and start with a newly unwrapped half, as the exposed blades seem to lose their edge. It is essential to have a very sharp cutting edge, and so a further segment of the blade should be broken off parallel to the first "pointing" or oblique break (Fig. 3, broken line) just before sectioning each object.

Sectioning is done on the stage of a dissecting microscope, the stage being nearly at table level, so that there is adequate support for the operator's forearms. A magnification of 10–20 diam is adequate, permitting a sufficiently wide field and ample depth of focus. The object-bearing slide is placed on the microscope stage so that the desired plane of sectioning is oriented about 60° counterclockwise from vertical (i.e., running from about 10 o'clock to about 4 o'clock) in the field of the microscope (Fig. 4), and with the material a little way toward 8 o'clock from the center of the field. Another microscope slide (Fig. 4) is placed over the object as a guide for the razor blade, with the portion of the object to be sectioned half-protruding from under the end of the guide slide. The end of this guide slide should parallel the plane of sectioning and extend to the left (or right for left-handed people). Its right end should be far enough toward 8 o'clock in the microscope field that its end surface can be seen.

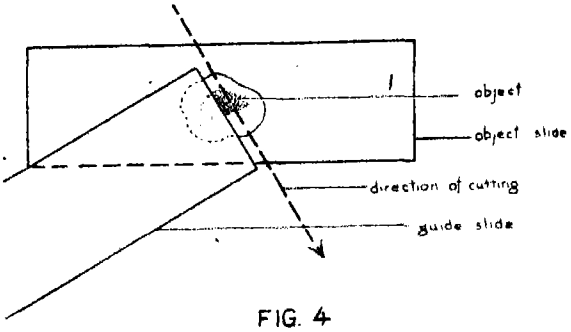

FIG. 4

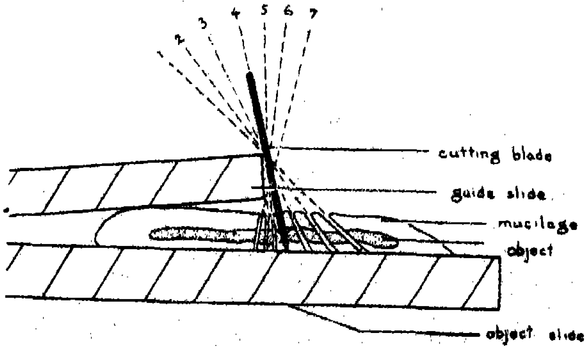

FIG. 5

The guide slide should be held with the left hand and the prepared razor blade in the right hand. Cuts are then made across the mucilage area with the direction of cutting (Fig. 4) from upper left to lower right and with the flat face of the razor blade in contact with the guide slide. The first cuts are made with the razor blade inclined (position 1 in Fig. 5) so that the cutting edge in contact with the object-bearing slide is at a distance from the end face of the guide slide. Cuts are made clear through the mucilage and object to the glass. With successive cuts the razor blade is brought more nearly erect (positions 1 through 4 in Fig. 5). These cuts bring the razor blade more nearly perpendicular and nearer and nearer to the end face of the guide slide. This procedure controls the thickness of the sections. By the time sufficient sections have been cut to bring the razor blade nearly perpendicular the operator has the feel of the particular object-mucilage mount and of the razor blade. The material should be so placed that the critical sections can now be made by continuing the process of slicing and straightening up the blade with each successive slice (positions 4 through 7 in Fig. 5). The best sections, i.e., the thinnest and most perpendicular, are obtained, as a rule, just when the razor blade is brought perpendicular (position 5 in Fig. 5) and past perpendicular (positions 6 and 7 in Fig. 5) by slanting the razor blade to cut under the guide slide edge.

After slicing is completed through the desired area, the guide slide is removed and a drop of water or dilute glycerine is placed over the mucilage-impregnated sections. In a minute or two the sections will float free, or nearly free, as the mucilage softens. The thick, unsectioned portions of the object may be removed with a dissecting needle and the remaining sections spread about. The sections may then be stained or treated in any manner which may be required.

The technique works equally well with fresh, dried, or preserved materials. Moreover, a section may be obtained with a high degree of success, with almost no equipment, and with a minimum of experience when just one pin-point object is available. Sections have been obtained easily and consistently of materials that are somewhat less than 5 μ thick.

Effect of a Folic Acid Antagonist on Hormonally Induced Changes in the Rat Prostate

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A definite relationship has been demonstrated in the chick between estrogen utilization and folic acid requirement (*1*). That this relationship is not based simply on a general impairment of body growth has been shown by the fact that optimal oviduct responses to stilboestrol occur in riboflavin- and pyridoxine-deficient chicks. In a more recent development, Hertz has found that the tissue growth response of the chick oviduct to stilboestrol can be blocked by the administration of a folic acid antagonist, presumably by competitive displacement of essential folic acid (*2*). This explanation is supported by the observation that the inhibitive effect can be completely reversed by the administration of excess folic acid.

In the course of an investigation into growth mechanisms of the rat prostate,[1] the foregoing findings raised several questions: 1. The use of a folic acid antagonist to inhibit the *stimulating* potential of an estrogen had been clearly shown in the chick. Could the usual *depressant* effect of estrogen on the rat prostate be nullified in a similar manner? 2. If such were the case, was there a possibility that the folic acid antagonist possessed androgenic characteristics *sui generis?* 3. If the antifolic principle did not inhibit the usual effect of the estrogen on the prostate, the probability was good that the blocking action was directed only at that function of the biological activity of the estrogen concerned with tissue growth. If so, might it not therefore inhibit androgen-stimulated growth as well?

The results of experiments designed to test the above hypotheses are summarized in Table 1. It will be seen that: 1. The use of the folic acid antagonist[2] partially,

TABLE 1

Exp.	Type of rat*	No. used	Average rat wt. in g	Mode of treatment	Average prostate wt. in mg†
1	Intact adult	7	201	α-estradiol	190
	" "	7	231	α-estradiol and aminopterin	373
2A	Intact adult	5	277	aminopterin	469
	Castrate adult	5	238	aminopterin‡	89
2B	Intact immature	5	62	....	33
	" "	5	61	testosterone	59
	" "	7	54	aminopterin	28
	" "	3	59	testosterone and aminopterin	53
3	Castrate adult	5	223	testosterone‡	380
	" "	5	202	testosterone‡ and aminopterin‡	406

* The adult rats used in these experiments were of the Sherman strain, and ranged in age from 90 to 120 days. The immature rats were obtained from Carworth Farms (Wistar) and were approximately 30 days old.

† Combined weight of anterior (ventral) and posterior lobes, except in Exp. 2B, where only anterior lobes were used.

‡ Begun 24 hr postcastrationally.

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[1] This study is being done in part under an American Cancer Society grant, recommended by the Committee on Growth of the National Research Council, and in part by a grant from the National Brewing Company. The author would like to extend his thanks to Dr. William Wallace Scott for his kind assistance in this work.

[2] Aminopterin (4-amino pteroyl glutamic acid), a product of the Lederle Laboratories, was kindly furnished by Dr. E. B. Schoenbach, of the Johns Hopkins School of Medicine, who also supplied much valuable information derived from his experiences with the compound. The daily dose used in these experiments was 0.2 mg/kg body weight in aqueous solution. Subcutaneous injections were given for 6–7 days, and the animals were sacrificed 24 hr after the last injection.

if not completely, interfered with the ordinary depressive influence of α-estradiol[a] on the rat prostate. (Table 1, exp. 1.) This finding in a sense confirms, but also extends Hertz' recent observations in the chick (*2*). 2. Furthermore, the folic acid antagonist possessed no androgenic potential itself, as judged by its inability to stimulate prostatic growth in castrate adult, and intact immature rats. (Table 1, exps. 2A and 2B.) 3. Lastly, no interference with androgen[a] stimulation of tissue growth is occasioned by the folic acid antagonist in castrate adult or intact immature rats. (Table 1, exps. 2B and 3.) From this we may reason that folic acid is not a prerequisite for hormonally induced growth in general, but is only essential for the proper utilization of estrogen, either in a stimulant or depressant capacity.

Further investigation of this problem is in progress, using other folic acid antagonists than the one employed here. These studies will be reported subsequently in a paper which will also include complete histological details.

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Metabolism of I^{131} in Severe Anoxic Anoxia

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Clinical reports (*3, 4, 6*) have indicated symptomatic improvement of hyperthyroid patients who sojourn at high altitudes. Rats exposed to severe anoxic conditions demonstrated an oxygen consumption 40–50% of normal (*1, 7*). These results suggest involvement of the thyroid gland in accommodation to anoxia. The present investigation was undertaken to determine whether any significant alterations in metabolism of radioactive iodine could be detected in relatively acute exposures to severe anoxic anoxia.

Eighteen rats were fed a low iodine diet (*5*) for 8 weeks, after which half of the animals served as controls and the other half were exposed to 268 mm Hg air pressure (which stimulated a 27,000-ft altitude) at 15–20° C. The low pressure rats were subjected to this anoxia for 12 hr and were then returned to sea level for injection of I^{131}. Within 3 min they were re-exposed to the low pressure for an additional 24 hr, after which they were sacrificed. The sea level control animals were also kept at 15–20° C and likewise injected with I^{131} 24 hr before they were sacrificed. All injections of radioactive iodine consisted of 10 μc in 0.5 cc of physiological saline (pH = 8.0) administered intraperitoneally. In each rat the total I^{131} was determined in the thyroid gland and in a sample of plasma. Plasma I^{131} was fractionated by the addition of 5 volumes of 10% trichloroacetic acid to separate "protein bound" I^{131} (*2*). Urinary excretions from the two groups of male animals were pooled as two samples. The data are summarized in Tables 1 and 2.

TABLE 1

FRACTIONATION OF PLASMA RADIOACTIVE IODINE

Experimental conditions	Male rats		Female rats	
	% Plasma I^{131}			
	Filtrate*	Ppt.†	Filtrate*	Ppt.†
Sea level controls	22	78		
	22	78		
	14	86	62	38
	47	53	46	54
	26	75	46	54
avg	26	74	51	49
Anoxic rats	88	12		
	90	10	98	2
	95	5	98	2
	95	5	97	2
avg	91	8	98	2

* Trichloro-acetic acid filtrate.
† Trichrolo-acetic acid precipitate (protein bound fraction).

The anoxic rats demonstrated a pronounced reduction in protein bound I^{131} in plasma. The average values expressed as percent of plasma I^{131} for male animals were as follows: trichloro-acetic acid filtrate of plasma of control rats 26%, and of the anoxic rats 91%; trichloroacetic acid precipitate of plasma of control rats 74%, and the anoxic rats 8%. In the case of female rats, the anoxic animals demonstrated an even greater depression of the protein bound I^{131} fraction, but the control values were also somewhat different from those of the male animals. It appears inadvisable to account for the ap-

TABLE 2

DISTRIBUTION OF I^{131} IN URINE, PLASMA AND THYROID GLAND

Experimental conditions	Male (10 rats 170–230 g)			Female (6 rats 140–180 g)		
	% of injected dose I^{131}					
	Total urine (pooled*)	Plasma (1 cc)	Thyroid gland	Total urine	Plasma (1 cc)	Thyroid gland
Sea level controls	30	0.78	76	(Not determined)	0.23	50
		0.64	70		0.23	53
		0.76	40		0.38	
		0.78	55			
		0.57				
		0.14				
avg		0.62	62		0.28	52
Anoxic	22	0.57	53	(Not determined)	0.57	31
		0.64	43		0.67	28
		0.16	46		0.57	28
		0.71	66			
avg		0.52	42		0.60	29

* Pooled urine sample, calculated as % of dose per rat.

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[a] Crystalline α-estradiol and testosterone were obtained through the courtesy of the Schering Corporation. The daily dose of these substances was 0.1 mg in sesame oil; the same injection schedule was used as that for aminopterin.

parently different results obtained from the two sexes (see Tables 1 and 2).

Table 2 indicates that the influences of anoxia upon I^{131} in unfractionated plasma, in thyroid, or in urine were not as striking as the effect upon protein bound I^{131} of plasma (Table 1).

The data in Table 1 may result from an almost complete suppression of a portion of the thyroid activity under these experimental conditions. More detailed experiments are necessary to substantiate such a conclusion.

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The Use of Detergents for Quantitative Fat Determinations

1. Determination of Fat in Milk[1]

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The determination of fat content has long been an important aid in clinical investigation and in the dairy industry, involving in most instances the use of long, technically difficult procedures and extensive laboratory equipment. Babcock's method and modifications thereof are widely used in the dairy industry because of their comparative simplicity, but even these have certain disadvantages. Sulphuric acid, used in the tests, often causes charring and consequent inaccurate results; caution must be observed in handling the acid and glassware to prevent burns; and as many as three different centrifugations must be carried out for each test. The method outlined in this paper was created to obviate these difficulties.

In this investigation a comparatively new principle is used—formation of a protein-detergent complex to break up emulsions and liberate the fat contained therein. The dispersion principle of detergents was originally used clinically to increase the bactericidal effect of antiseptics (*2*) and is now also used in the laboratory to dissolve sputa for the purpose of isolating and concentrating tubercle bacilli (*3*). The combined solvent action of the two detergents described here has resulted in a very satisfactory method for the determination of fat in milk and shows promise as a universal procedure for the measurement of fat.

Materials. (A) A supersaturated solution of a fat dye is prepared by mixing 500 mg of oil red O in 100 ml of isopropyl alcohol. Two and one-half ml of the clear solution is added to a mixture of 100 g of a standardized nonionic detergent, polyoxyethylene sorbitan monolaurate, and 65 ml of 95% ethyl alcohol, and the new mixture is shaken. (B) The other reagent is a standardized anionic detergent, dioctyl sodium phosphate.

Procedure. (1) A well-mixed sample (17.6 ml) of milk is placed in a Babcock milk bottle. (2) Seven ml of solution (A) is placed in the vessel, which is then shaken immediately to mix the contents intimately. (3) Thirteen ml of reagent (B) is added without further shaking so that this last addition forms a layer at the bottom of the container. (4) The container is immersed in a water bath at 180° F. The water level in the bath should be approximately equal to that in the bottle. (5) After 5 min in the bath, water at 180° F is added to the Babcock flask until the fluid level reaches the top of the graduated portion. (6) The flask is then set aside at room temperature for 10 min, after which the percentage of fat (as in the Babcock test) is read by subtracting the lower meniscus reading from that of the upper meniscus.

One hundred duplicate samples of milk were tested for quantitative fat content. The readings obtained by this method were the same as those resulting from the Babcock test. Detailed comparison of readings obtained with various types of milk, and comparison of methods for cream and ice cream will be presented soon.

The test is based primarily upon three factors: (1) a proper order in mixing of reagents and specimen to obtain maximum effect of the reagents individually and combined; (2) correct proportioning of the reagent emulsion complex by adjusting the quantity of the nonionic detergent to the type of emulsion (milk, ice cream, etc.) from which the fat is to be extracted; and (3) a proper temperature at which the reaction takes place optimally. In addition to these factors, intervals between steps should not be prolonged; the shaking, when prescribed, should be sufficiently thorough to distribute the contents evenly; and the time of reaction should be exact.

Milk fat exists in milk in the form of minute globules constituting a true emulsion of the oil-in-water type, the fat globules being in the dispersed phase. Each globule of fat is surrounded by a very thin film of protein in the serum of the milk, concentrated on the surface and held in place by surface attractions or adsorption. The protein layer may contain some lecithin to form a protein-lecithin layer on the surface of the fat molecule. This concentration of the milk proteins around the fat globule is one factor which assists in maintaining the stability of the fat emulsion in milk.

Dioctyl sodium phosphate is an anionic compound in which the hydrophilic portion is negatively charged. It has a long chain of carbon atoms with a strong polar group located near the center of the carbon chain. With a given chain length of a detergent, the position of the hydrophilic groups is an important variable in the determination of the surface active properties of the resultant molecule. Dreger and his co-workers (*1*) showed that the activity of detergents increased when the hydrophilic groups were attached near the center of the carbon chain.

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[1] Published with the permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the author.

Mixing this detergent with milk and heating the combination effects a dispersion of the protein layer around the fat globule, liberating the fat so that it can combine with other fat molecules. However, the separation is not complete. When a quantity of the strongly hydrophilic, nonionic detergent is added to the mixture, a clear solution and complete separation results.

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On the Food Selectivity of Oysters

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The question whether oysters and other closely related mollusks can, in selecting their food, discriminate between the different types of microorganisms has been debated since the end of the last century, but no general agreement has been reached as yet. Among others, Lotsy (*5*) and Grave (*2*) thought that, in their feeding, oysters show a definite selection of particles having food value. Another group, represented by Kellogg (*3*) and Yonge (*7*), maintains that in lamellibranchs the selection of particles is purely quantitative. Yonge (*7*) thinks the main objective of this selection is "the reduction of the quantity of matter passed to the mouth, large particles or many small particles embedded in mucus being rejected and smaller particles or mucus masses passed on to the mouth quite irrespective of their food value."

My observations and experiments make me agree with Lotsy and Grave that oysters (*O. virginica*) do show some selectivity in feeding. In several of our feeding experiments in which yeast cells in very small numbers were added to running sea water many oysters rejected most of the yeast in pseudofeces, while the true feces were composed largely of plankton forms and detritus normally present in our waters (Loosanoff and Engle, *4*). It is significant that the yeast cells were rejected even if their size (about 5 μ diam) was equal or even smaller than that of the many forms ingested by oysters. This clearly indicated that the discrimination against yeast cells was not based upon their size.

Recently I had the opportunity to observe even more striking cases of selectivity shown by oysters in their feeding. In the summer and fall of 1948, during periods when sea water contained relatively little food material, we were adding at a constant rate small quantities of plankton culture to the water flowing into the trays containing experimental oysters. This culture, which was grown outdoors in a 3000-gal wooden tank, contained a variety of different algae, flagellates, and bacteria. The color of the culture was usually light brown or a purple-brown. In feeding this culture to the oysters I noticed that in many cases the pseudofeces formed were purple or pink, while the color of the material that was swallowed by the oysters and passed through the digestive system was greenish-brown.

Microscopic examination showed that the purple pseudofeces consisted principally of a round-shaped form measuring 2 to 3 μ diam. The true feces, on the other hand, consisted of plankton normally present in our water and of relatively small numbers of the purple form. On the basis of morphological examination, this form has been tentatively identified by S. F. Snieszko of our service as being a species of the genus *Chromatium perty*, which contains purple sulfur bacteria.

On several occasions I was able to grow, in flasks, cultures consisting predominantly of chromatia. The cultures developed best if placed near a southern window in strong light. The color of the good cultures was almost purple. When these cultures were added to the greenish-brown cultures fed to the oysters the latter soon formed purple pseudofeces composed largely of chromatia, while the feces remained a normal, greenish-brown color.

I have noticed that the most energetic rejection of the purple form by oysters took place usually during the first few days after it was added to the water. Later on, some of the oysters evidently developed tolerance to this form and ingested it without apparent discrimination. As usual, the oysters showed considerable individual variations in their feeding behavior, i.e., while some of them ingested *Chromatium* within a few hours after it was first added to the water, the others continued to reject it even after several weeks of contact.

Because *Chromatium* is smaller than many other forms ingested by oysters, we cannot ascribe its rejection to its size. It is more probable that as Cobb (*1*) has shown for *Anodonta*, the palps of which responded to a variety of stimuli, including those of a chemical nature, the palps of oysters may possess specialized cells which act as chemoreceptors, and may be sensitive not only to the physical characters of plankton forms, such as their size and shape, but also to their chemical properties. Nelson (*6*) says that feeding of oysters also is a complex process involving the interaction of the muscular, ciliary, secretory, and nervous tissues. Thus, I think, the selection of food may be based in part on the nature of the secretions of different species of microorganisms reaching the palps, and therefore, as the observations on the rejection of chromatia indicate, at least in some instances, oysters can select their food not only quantitatively but also qualitatively.

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Comments and Communications

Two Aspects of the Loyalty Problem

The integrity of science and scientific education in this country is seriously jeopardized, and can be maintained only if scientists generally and the National Research Council in particular are alerted to the dangers inherent in the requirement of clearance and "loyalty" oaths for research fellowships and nonsecret work. Actually the dangers are not confined to science, although they are most acute there. The principle stated by the Congressional interrogators of Dr. Smyth and others is that no one should be educated at public expense who may not be acceptable for government work by the terms of the Federal Loyalty Order—"who would not in the future be eligible to work for the Government in classified fields." This would apply to National Science Foundation fellowships and any other publicly supported grants. In view of the clearance difficulties of some of our most outstanding scientists, and the irresponsible interpretations recently given to routine FBI reports, this condition is manifestly generating fear and insecurity.

An oath unaccompanied by an FBI investigation may sound harmless—an oath of allegiance, as a safeguard against treason, is surely unexceptionable. But an oath covering "past and present membership in various organizations," *under penalty of perjury*, to determine the "subversive and reasonably potentially subversive," is quite another matter, and it is on this that some scientists have compromised. Our Atomic Energy Commission fellows have already been asked to take general and inclusive oaths, subject to interpretations which can only become clear as time goes on. An oath involving the beliefs of both the individual signer and the organizations (whatever "belief" may mean in this case) to which he may belong or which he supports (whatever *that* means), has been written into the National Science Foundation bill now before the House of Representatives. It would be folly to expect that these oaths would not be followed by some sort of investigation, and any attempted guarantee to the contrary would be ridiculous. Oaths of this kind open the possibilities of irresponsible accusations, and of legal procedures based not on acts but on opinions which for one reason or another may not be popular at the moment. The chain of associations is endless. Will the professor be deterred from making recommendations without investigating his student's views, since any difficulties will also involve him? Dare a student study with any nonconformist professor, however brilliant, since he may need simon-pure recommendations?

The words "subversive" and especially "potentially subversive" are variable terms; on the whole they are expanding, becoming more comprehensive, at the present period. According to Senator Hickenlooper, subversive "probably means generally someone who believes in doing substantial harm to our form of government and to our institutions." One could agree unthinkingly, yet only a few years ago a National Science Foundation itself was regarded as an idea considerably to the left of center, and it took a brave scientist to stand up and defend publicly the public support of science. How about national health insurance, and public housing? According to many they will do substantial harm to our institutions, and even to our form of government. And one has only to *believe in* them.

It is a wholesome exercise to remind ourselves that there have been definitions of loyalty quite different from that in current vogue. According to the Connecticut Yankee (italics Mark Twain's):

> You see my kind of loyalty was loyalty to one's country, not to its institutions or its office-holders. The country is the real thing, the substantial thing, the eternal thing; it is the thing to watch over, and care for, and be loyal to; institutions are extraneous, they are its mere clothing, and clothing can wear out, become ragged, cease to be comfortable, cease to protect the body from winter, disease and death. To be loyal to rags, to shout for rags, to worship rags, to die for rags—that is a loyalty of unreason, it is pure animal; it belongs to monarchy, was invented by monarchy; let monarchy keep it. I was from Connecticut, whose Constitution declares "that all political power is inherent in the people, and all free governments are founded on their authority and instituted for their benefit; and that they have *at all times an undeniable and indefeasible right to alter their form of government* in such a manner as they may think expedient."
>
> Under that gospel, the citizen who thinks he sees that the commonwealth's political clothes are worn out, and yet holds his peace and does not agitate for a new suit, is disloyal; he is a traitor. That he may be the only one who thinks he sees this decay, does not excuse him; it is his duty to agitate anyway, and it is the duty of the others to vote him down if they do not see the matter as he does.

Of course this is a very radical statement; one would not have to go nearly so far as to act in accord with it to be refused clearance for secret work. We are perhaps not in immediate danger of having Mark Twain barred from school libraries, but we are already afraid of having people take him, or the constitution of Connecticut, too seriously. And unless we resist completely this latest invasion of the personal beliefs of students and their teachers, we are inviting the kind of atmosphere which pervaded Germany in the thirties, stifling academic achievement generally and science in particular.

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The Scientists' Committee on Loyalty Problems has been studying the loyalty and security clearance procedures of different government agencies for some time.

While these procedures could be improved in many ways, the committee wishes to point out to scientists that they themselves, even under present procedures, can better the situation.

The following proposal aims at raising the level of the confidential reports on which clearance decisions are based. In most investigations, agents of the FBI obtain information from friends, neighbors, and colleagues of the person to be cleared, as well as from less direct sources. The results are collected in a confidential dossier in which the sources of information are often anonymous, or revealed only to a very limited number of officials. It is obvious that these unacknowledgeable statements can cause serious misunderstanding which cannot easily be clarified, especially in cases where the clearance status meets with difficulties.

It is, therefore, strongly recommended that all scientists adhere to the following rules whenever possible: (1) When giving information to loyalty and security investigators, state willingness to testify if necessary. (2) Prepare a signed, written statement of the information for the investigating agency.

SCIENTISTS' COMMITTEE ON LOYALTY PROBLEMS: *Lyman Spitzer, Jr.*, Chairman; *William A. Higinbotham*, Associate Chairman; *Arthur S. Wightman*, Secretary; *Donald F. Hamilton*, Treasurer; *David Bohm, Roy Britten, Robert R. Bush, Elmer G. Butler, Albert Einstein, Luther P. Eisenhart, Samuel A. Goudsmit, M. Stanley Livingston, Stuart Mudd, David Pines, Oswald Veblen, Irving Wolff.*

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The Northern Limit of the Fauna of the African Equatorial Forest

While in the southern Sudan in 1948 with the U. S. Navy Medical Science Group (University of California African Expedition) I gathered material and information concerning the fauna of the forested mountain ranges of the Latuka country in the eastern part of Equatoria Province.

The Imatong Mountains (10,376 feet = 3163 meters) and Didinga Mountains (8935 feet = 2724 meters) are the highest elevations between the mountains of Kenya and Uganda and the highland of Ethiopia. Four species of mammals belonging to the forest fauna have been previously recorded from this area and can now be correctly identified, thus serving as index species for an appraisal of this fauna. They are (1) Black and White Colobus Monkey, *Colobus polykomos occidentalis* Rochebrune (syn. *dodingae* Matschie), (2) Blue Monkey, *Cercopithecus mitis stuhlmanni* Matschie (*otoleucus* Sclater), (3) Bushbuck, *Tragelaphus scriptus delamerei* Pocock (*dodingae* Matschie, *locorinae* Matschie, *barkeri* (Millais), (4) Blue Duiker (*Philantomba monticola aequatorialis* Matschie), (5) From descriptions received locally, although no specimens were obtained, it appears probable that the Black Mangabey (*Cercocebus albigena johnstoni* Lydekker) also occurs.

These forms are subspecifically identical with those occurring in the forests of Uganda and in the Ituri forest. They indicate that the reduction of the continuous forest and the development of the forest islands in the East Nile area are of fairly recent origin. On the other hand the separation of the mountain forests of southern Ethiopia is more remote. The species of this forest fauna are subspecifically distinct from those in the mountains of the Latuka country.

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A Statement of the Governing Board of the A.I.B.S.

For more than a decade, biological scientists and particularly geneticists and cytologists in the USSR have been attacked by so-called "Michurinists," led by T. D. Lysenko, now a high government official and a public figure. Lysenko and his followers have declared the principal attainments of genetics and cytology, including Mendel's laws, to be invalid. This has been done in a manner which shows clearly that Lysenko is either unfamiliar with, or else is willfully ignoring, the basic facts and the methods of investigation of the sciences which he presumes to negate. On the other hand, Lysenko and his adherents have claimed successful experiments with higher organisms demonstrating directed hereditary changes of a useful kind, by means of adaptive responses that later were inherited. Such phenomena would have been of great theoretical and practical value if confirmable. However, outside Lysenko's group in the USSR, such confirmation has proved impossible.

The necessity for clarifying the situation becomes all the greater because Russian spokesmen, such as I. I. Prezent and S. Kaftanov, quote from the works of Western geneticists in support of their views. This Communist party line has even penetrated in subtle ways into reputable weekly and daily journals in France, England, and the United States. The opinion is consequently spreading that modern genetic researches in the West support the official Communist views on heredity. Nothing could be farther from the truth. Authors quoted by the Russians have strongly denied the validity of drawing such conclusions from their studies. In no case has their work discredited or contradicted the firmly established validity of the gene. They resent having their papers cited as leading to such a discrediting, for this is a manifest reversal of their data and of the intent of their statements.

The opinions and claims of Lysenko and his followers have become a matter of especially serious concern to scientists everywhere because the government of the USSR has not only approved and supported the Lysenko group, but has also condemned and suppressed those biologists in the USSR who have disagreed with Lysenko and who have tried to continue their research in the fields of genetics, cytology, and related sciences. As reported in recent months by the world press, and published in the official newspapers of the USSR, the views of Lysenko have been endorsed by the government organs directing scientific research in that country—among them the

Academy of Sciences of the USSR, the Academy of Agricultural Sciences, and the Academy of Medicine. More serious still, geneticists, cytologists, and evolutionists as eminent in their fields and as well known to their colleagues all over the world as Dubinin, Schmalhausen, Zavadovsky, and others have been removed from their positions, deprived of their laboratories, or led to make shameful declarations of their supposed acceptance of Lysenko's view. Finally, the temper of this supposedly scientific controversy may be appreciated by the pronouncements of S. Kaftanov, Minister of Higher Education, to the effect that all anti-Lysenko doctrine must be systematically rooted out of the schools, universities, research institutes, and publishing houses.

It may be left to the judgment of scientists, friends of science, and all fair-minded people to arrive at their own conclusions regarding the propriety of governments and political parties not only deciding a supposedly scientific controversy in favor of one and against another theory, but also dismissing scientists and depriving them of the means of conducting their research, and too often of their lives, because of their adherence to a scientific theory accepted everywhere on this side of the iron curtain. As representatives of American scientific societies devoted to furtherance of research and study in genetics, we feel it our duty to state that the contention raised by Lysenko and his "Michurinists" against genetics does not represent a controversy of two opposing schools of scientific thought. It is in reality a conflict between politics and science. Today the condemned science happens to be genetics. Indeed, the conflict has already spread to other biological fields, and eminent physiologists, embryologists, microbiologists, and others are now being dismissed in the USSR. Tomorrow still other sciences may be proscribed.

The progress of science has always depended upon free inquiry. The inheritance of acquired characteristics, and other doctrines that the Russians now set forth as the official party line, have had their proponents in America; some nongeneticists still hold to these ancient opinions. Nevertheless, they are allowed to investigate or philosophize, and they have a hearing. In Russia, on the other hand, geneticists are being rooted out as dangerous, bourgeois, reactionary, idealist, fascist, regardless of their political views, simply because they, like geneticists everywhere else in the world, know and accept the facts of experimental breeding and microscopic observation which Russian politics has branded false. It is of the utmost importance for the preservation of free inquiry in that part of the world where it still exists that these facts be known and fully appreciated.

The Governing Board of the American Institute of Biological Sciences, an organization representing American societies in numerous fields of biology, is issuing the present statement after consultation with the executive committees of those societies in its organization which deal more particularly with the matters here at issue—namely, the Genetics Society of America and the American Society of Human Genetics. We would sum up our positions in the following propositions:

1. In our opinion the conclusions of Lysenko and his group regarding the inheritance of adaptive responses in higher organisms have no support in scientific fact.
2. Genetic researches definitely support the reality of the gene and the validity of Mendel's laws. They do not support the official Communist claim that Mendelian heredity is an illusion, and any attempts on the part of Russian proponents of the Lysenko doctrines to bolster their case by citations from the works or conclusions of Western scientists are gross distortions of the meaning and intent of these scientists.
3. We condemn the action of the Soviet government in presuming to banish a firmly established science from its schools, publishing houses, and research laboratories, and in persecuting scientists because their field of inquiry is distasteful to the government.

E. G. Butler
T. C. Byerly
F. P. Cullinan
W. O. Fenn
R. E. Cleland
Executive Committee

Governing Board
American Institute of Biological Sciences

S. 1703 and the Antivivisectionists

Science will probably lose by default its present legislative battle against one of its most vocal and powerful enemies—the antivivisection cult.

Representatives from twenty-six national health and science groups, local hospitals, universities, lay groups, and governmental agencies met in Washington the second week of July to discuss the political future of Senate Bill 1703, medical science's first Congressional broadside against the antivivisectionists.

Specifically, the bill would enable District of Columbia scientific institutions to utilize a portion of the seven to ten thousand unclaimed and unwanted animals now annually destroyed in the District pound. The experimental use of these dogs which would otherwise be uselessly killed could speed research and teaching in the universities and government agencies of the nation's capital.

The bill applies to the District of Columbia only. Actually, however, because of its precedent-establishing nature, the legislation is of national importance.

A. C. Ivy, secretary-treasurer of the National Society for Medical Research, reported to the Washington meeting that a recent legislative conference revealed the bill would probably remain in committee because scientists and the friends of science have failed to express themselves on the matter. Dr. Ivy pointed out that members of the special Senate subcommittee to which the bill was referred are personally in favor of the bill, but that an organized flood of antivivisectionist mail has introduced political complications.

Senator Margaret Chase Smith of Maine, the chairman of the subcommittee, has received the brunt of the antivivisectionist pressure. Although she recognizes the great need for the bill's enactment, Senator Smith apparently regards the measure as a political "hot potato" and hopes to avoid political pressure from the small-numbered but extremely militant antivisisectionists by keeping the bill in committee. Senator J. Howard McGrath of Rhode Island, another subcommitee member, who introduced S. 1703, has also been subjected to antivivisectionist political pressure.

Scientists and their friends should write to Senator McGrath supporting S. 1703 and to Senator Smith urging the subcommittee to recommend the bill.

As Dr. Ivy said, "The preposterous and dangerous situation which the antivivisection movement has produced is really the scientist's fault. Our lack of effort in the past has enabled the antivivisectionists to achieve their present restrictions on research and teaching. It would be more than a tragedy if further inertia were to continue and this important legislation suffer a defeat."

Bruce Shelly

National Society for Medical Research,
Chicago

On the Application of Scientific Procedure to the Social Sciences

In a letter published in *Science* (March 18, 1949) Edgar G. Miller, Jr., says "Science is not any particular method or set of techniques. It is a way of reasoning. The standards are intellectual rather than procedural." These statements are part of an argument showing that it is wrong to criticize the social sciences on the ground that they do not use the "procedural" methods of natural science. The writer says further that "the validity of the scientific method is not confined to any one procedure."

I believe this is a misapprehension. Natural scientists have discovered, rather late in history, that science can progress only if it is made impersonal and objective. Observations of facts in nature have to be independent of the observer—of his language, race, religion, intellectual power, and above all his motives. The "procedure" for ensuring this is simply to require that any fact be observable or demonstrable at all times to anyone, before it is admitted as a part of science. Only since enforcement of this procedure has science truly grown; and, conversely, if it were relaxed science would retrogress to the days of alchemy and astrology. This applies to descriptive sciences like geology as well as to laboratory sciences like chemistry. The facts of descriptive science must be demonstrable. Any hypothesis which may be constructed must be labeled as such; it must be held plausible only as it codifies observations, and useful only as it leads to further observations. Until it is rigorously—procedurally—checked, it may not be used in demonstrations, simply because that would be assuming what is to be proved. It is only thus that science can purge itself of errors—especially errors stemming from the desire to prove something preconceived rather than to ascertain the truth.

It does not follow that the intellectual tools of science—hypothesis before the fact, and logic after it—are unimportant. It is just that they are not sufficient. Logic and hypothesis existed long before science made any serious progress. The theologies and philosophical schools that flourished in the predemonstration days were the work of men whose intellect and imagination were as good as our own. Their hypotheses were brilliant, their logic profound and subtle. Their common defect was simply that they did not check their premises by observation. The consequence was that their systems of thought were generally of low usefulness as descriptions of nature or as bases for scientific advance. The writings of Aristotle furnish plenty of classical examples in illustration. What is proved by thinking depends on the premises, and if the premises are arbitrary or unrelated to nature the conclusions will be the same. Such pursuits as chess playing and theology have intellectual standards as exacting as those of natural science, but they are not science, because they have nothing to do with nature, and may exist purely in the mind. It was not until thinkers applied the criterion—procedure—of checking their teachings one by one against observation, and excluding from science anything that could not be so checked, that the success and prestige of present-day science could begin to grow.

All this does not mean that further effort in the social sciences is useless unless they confine themselves to the observational method. In history, for example, it is impossible to use the critical procedure of physics or chemistry. That does not prove that history is not a useful or rewarding study; a thorough knowledge of history on the part of today's citizens might benefit humanity more than the know-how of rockets and atom bombs. It does prove that history is not a natural science, and that a prediction of future events, or even a recital of past ones, is and remains an opinion judicially based on limited evidence, instead of an objective fact to be built on with confidence. The modern social sciences are in a somewhat different position; many of their teachings are objective and demonstrable. But many others are not, and perhaps never will be; and failure to differentiate between fact and hypothesis can serve only to debase future work in the field. The consensus of scientific thought will be, I think, that social science may best advance by checking as many of its teachings as possible against experiment and observation, and rigidly separating these from the teachings that are as yet unconfirmed by critical procedure and are therefore still hypotheses or assumptions—to be regarded as *useful* instead of *true*, and above all to be treated with the impersonal skepticism of the scientist instead of the interested faith of the prophet.

Frederick Romberg

Austin, Texas

Book Reviews

Our sun. Donald H. Menzel. The Harvard Books on Astronomy. Philadelphia: The Blakiston Company, 1949. Pp. 326. $4.50.

One of Dr. Menzel's principal contributions to astrophysical thought has been his insistence, often in the face of opposition, that the stars must not be regarded as static formations, but rather as turbulent masses of gas whose outer layers are constantly moving about in different directions, giving rise to tremendous prominences, extended atmospheres, coronas, and various types of corpuscular radiations. His new book on the sun shows why he has maintained this picture of a star. There is every reason to believe that the sun is not unusual and that its prominences, spots, flocculi, and flares are regular properties of most stars.

The book is full of useful and up-to-date information. The first eight chapters describe the various features of the solar surface, including recent developments in infrared spectroscopy at the University of Michigan and elsewhere. The problem of the spicules recently discussed at the Harvard High Altitude Observatory in Climax is treated in detail, as are also the new results on prominences derived by means of moving picture cameras.

Chapter 9 is an account of the corona and gives a thorough discussion of Edlén's identification of the coronal lines and of Lyot's work on the shape of the corona. There is a section devoted to the solar radio noise, and a discussion of the theoretical implications of the high temperature of the corona.

Chapter 10 discusses the structure of the interior of the sun and the now generally accepted ideas of the source of the solar energy. Only one page is devoted to the origin of the solar system, probably because this topic was previously discussed by F. L. Whipple in his book *The earth, moon and planets*—another issue of the Harvard series.

Chapter 11 deals with the eclipses of the sun and records many personal experiences and observations of the author. Incidentally, the results of Van Biesbroeck's measurement of the relativity shift in 1947 have been known for some time. The value, as published in the *Astronomical Journal*, No. 1175, page 71, 1948, is 2.01 ± 0.18″.

The last chapter is devoted to those terrestrial effects which are correlated with solar phenomena. The illustrations are numerous and are exceptionally good, but Fig. 149, showing the Doppler effect of the recession of the spiral nebulae, although often used in various recent publications, is so heavily retouched that it gives an altogether erroneous impression of the spectral lines. The curve of growth shown in Fig. 59, although copied from another publication, is grossly misleading and should certainly be replaced by a more accurate diagram when this book is revised for a second edition.

Most readers will be surprised that Hale's great work on the sun is comparatively little recognized. For example, his invention of the spectroheliograph is dismissed in two sentences, and the enormous productivity of his own research and of that of his associates at the Kenwood, Yerkes, and Mount Wilson Observatories has not been accentuated, but has rather been submerged in the great mass of more recent advances. Despite these minor criticisms, the book is an important addition to the astrophysical literature. It is primarily intended for the amateurs, but professional astrophysicists will also find it a valuable and interesting summary of modern solar physics.

Otto Struve

Yerkes Observatory

Embryology. Lester George Barth. New York: The Dryden Press, 1949. Pp. viii + 330. (Illustrated). $5.00.

In the pedagogical realm, no science deserves more or has received less from its practitioners than embryology. No biological field offers more drama and excitement than the one which treats of the transformation of a simple, tiny egg into a complex being. Yet most textbooks of embryology in use today are calculated to give the student the impression that embryology is the deadest of the sciences. It is a pleasure to record that this situation has just been altered by the appearance of a college-level text in which development is analyzed as well as described. The book is *Embryology*, by L. G. Barth of Columbia University.

The book opens with a brief but compelling statement of the problems of embryology. The viewpoint indeed is primarily analytical throughout. For example, the experimental work on the make-up of the unfertilized egg, on gastrulation and the organizer, and on the gradual differentiation in the neurula stages, is dealt with before the actual development of the frog's egg is described. Moreover, although there are chapters specifically devoted to the traditional chick embryo and to the mammal, the author also draws on hydroids, flatworms, and echinoderms where they are useful in illustrating principles.

The order of topics is roughly chronological, beginning with ovulation and proceeding to the later phases of development, where the several organ systems are considered separately. In addition to the material conventionally treated in embryology texts, however, this book also deals with fertilization, regeneration, growth, sex differentiation, and embryonic physiology. In all cases an analytical approach is adopted wherever the material allows it, the tone throughout being critical and inquiring. The style, moreover, is clear and terse. It will be a poor student indeed who is not stimulated by the whole presentation.

Prof. Barth has no doubt done a brilliant job of reporting on an extremely broad field. In too many places, however, the coverage is superficial. Thus the difficult subject of avian gastrulation is dealt with in less than a page and a half, with no adequate illustrations; the visceral pouches are dismissed as "five evaginations from the side walls of the foregut"; embryonic excretion is glossed over in 160 words. Such superficiality particularly afflicts the descriptive sections, for the reason, the author says, that "the details of comparative and descriptive embryology are of specialized interest"! Why experimental embryology is less specialized than descriptive he does not explain, nor does he make it clear by what sort of transmigration a true understanding of experimental problems is to be conveyed into minds with the slipshod grounding in morphogenesis that he proposes.

But the principal weakness of the book lies in the illustrations. The line drawings range from poor to grotesque. At best they are too schematic; at worst they are the sort of graphic enigmas that can be resolved only by a practiced eye—and not always by that. Many are ill-proportioned and inaccurate in detail. It is difficult to see how the importance of exactness in observation and recording is to be impressed on students if they find such sloppy work in print. There are numerous photographs, but most of these are not very clear, despite the use throughout of glossy coated stock that makes the book hard to read. The detailed descriptive captions, however, are generally excellent.

That the book has shortcomings I record with regret, and in the hope that they will be corrected in a second edition. For the work is a most valuable contribution to the teaching of embryology. No other text comes close to it in laying before the undergraduate student the living, growing body of knowledge that is embryology.

FLORENCE MOOG

Washington University

The theory of solutions of high polymers. A. R. Miller. New York: Oxford Univ. Press, 1948. Pp. vi + 117. $3.25.

This small volume treats a very timely and important subject in a highly scientific and thorough manner; it is not a book for a man who wants to get a first general idea of the matter but it is an excellent, up-to-date presentation of our present ideas of the nature of macromolecular solutions and the modern ideas and mathematical methods used to represent their behavior in a quantitative manner.

After a short introduction dealing with the principles of statistical mechanics and a little information on the most important properties of macromolecules, the author proceeds to treat his main subject—namely, the statistical treatment of flexible long chain molecules in athermal solutions. This is done in a rigorous and general manner, yet the text always has great clarity and convincing simplicity.

A chapter on comparison of theory with experiment and another on treatment of solutions with appreciable heat of mixing complete the presentation of our present-day knowledge. A very stimulating chapter on possible extensions of the theory concludes the book, which is a valuable addition to the scientific literature and a masterpiece of clear and concise writing.

H. MARK

Polytechnic Institute of Brooklyn

Motor performance and growth: a developmental study of static dynamometric strength. Harold E. Jones. Berkeley and Los Angeles: Univ. California Press, 1949. Pp. x + 181. (Illustrated.) $2.00 paperbound, $3.00 cloth.

This painstaking research study is one of the few longitudinal studies in which the same individuals have been measured biannually from the 6th through the 12th grade, 11 to 17.5 years of age. The primary data include 139 middle-class students, divided about equally as to boys and girls from five elementary schools of Oakland, California. The measures consist mainly of static right and left grip, push and pull *dynamometer strength.* The significance of strength is shown in the large coefficients of variation during the adolescent growth spurt, these being greater than for any other physical or psychometric measures. The testing procedures are judged to have been good, since the reliability coefficients were .938 or above for the boys and .901 and above for the girls.

The selection of tests was dominated by convenience. Higher validities may be shown for the net contribution of leg strength to all-around athletic performance (Rogers' Montclair High School Data) and the superior validity of the dynamic tests over the static type is frankly acknowledged. Correlations are quoted from Espenschade's work (1940) to show that right grip and total strength correlate .50 and .34, respectively, with a track dash, .44 and .56 with the broad jump, .53 and .62 with a distance throw; low correlations of .27 and .29 are quoted for relationship to the jump and reach test and insignificant correlations are shown for the Brace motor ability test. To some considerable extent the book is a collaboration of several articles published in educational journals. Whereas total strength correlated .39 with age, .50 with skeletal age, .65 with height, .30 with popularity, .21 with good looks, insignificant correlations are shown for intelligence and socioeconomic status. Other authors (Bower, Jersild, Dimock) are quoted to sustain the role of strength in social leadership (reputation) and in athletics (Rogers, McCloy, Cureton).

As a whole the study confirms, on the basis of four types of growth causes, the studies of others to verify the prepubertal lag followed by the growth spurt, the differences between boys and girls after 13 years of age, and variable patterns of growth for early contrasted with late maturing cases. Tables of strength are given for each half-year of age from 11 to 17.5 years. Jones concludes that *strength is superior to the shock creative test,* the Crampton pubic hair method, or any other known method. It shows that early maturing boys and girls usually have greater total strength but in the early maturing girls there appears to be an arrest of growth that does not develop in the boys. The finding that the greatest growth for both boys and girls occurs in April and the least in October seems real but it is not well explained. This is in direct opposition to the findings in various weight studies, which show the greatest increase in the second half of the year.

The generalizations of the author as to educational implications are dominated by the belief that strength is almost wholly inherited and little credit is given to developmental or environmental influences. The author seems to have some prejudice against intensively competitive games and athletics in general, which is unsupported by data. The positive aspects of guidance are relatively undeveloped, although opinions and inferences abound in the final chapter which go beyond the meaning of the data, since no methods for developing strength have been tested.

THOMAS K. CURETON, JR.

University of Illinois, Urbana

Fieldbook of natural history. E. Laurence Palmer. New York: McGraw-Hill, 1949. Pp. x + 664. (Illustrated.) $5.00.

"Professor Palmer's *Fieldbook* is an extraordinarily comprehensive guide to natural history. Simply presented, and profusely illustrated, it embraces more than two thousand items—birds, fish, plants, rocks and minerals, the stars, mollusks, reptiles, and mammals. Each item is illustrated with a detailed drawing or photograph for quick and correct identification, and for each there is a descriptive paragraph, followed by data on range and location, life history, ecology, and economic importance. An unusual feature of the book is its inclusion of many domesticated and economically important species not usually found in books of this kind."

This quotation from an advance notice released by the publisher of the *Fieldbook* proves to be an accurate description. Here is encyclopedic information about a wide variety of subjects. It bids fair to become one of the most frequently used books on the desks of teachers, high school and college students, naturalists, game managers, game protectors, gardeners, nature lovers, sportsmen, and citizens generally who want to know something about their surroundings. The book should give a real impetus to efforts toward conservation education.

One doesn't have to be a specialist to use this book. Technical terms have been avoided. But the information is exact and can be referred to in its place in the taxonomic scale.

Most useful will be the drawings. While this book lacks conventional keys (which ordinarily cannot be used except by specialists anyway) there are hundreds of distinctive line drawings so that identification of plants, birds, or insects should be a comparatively simple matter. It is true that some of the outlines do not look just right, but this applies to few, and is by no means strange in view of the comprehensive coverage of the work. If colors could have been used the illustrations would have been somewhat more useful.

This reviewer has often wondered why, in our books on mammals and other species, we should not include the domesticated varieties, including man (although perhaps it is stretching a point to call man domesticated!). The *Fieldbook* does this, with excellent results.

Unfortunately, the author follows the American Ornithologists' Union Check-List in the use of the possessive, as "Gambel's quail" instead of the Gambel quail—as strained a usage as it would be to say "Vancouver's Island" or "Rainier's Mountain." The author cannot be too much blamed, however, since probably the majority of usage in ornithology, at least, follows this cumbersome practice.

In a work covering so large a field in natural history, it is inevitable that omissions should occur. Among these we note the absence of bicolor lespedeza and multiflora rose among plants. Since so many gardeners and game managers all over the country are concerning themselves with these species, with a zeal that smacks of a full-fledged fad in wildlife management, there are sure to be information-seekers who will be disappointed not to find them in this volume. But in general the material has been well selected and one would be captious indeed to press this comment.

The book is typographically attractive and accurate. Furthermore, it is equipped with a complete index which will greatly facilitate its use.

Another virtue of this book is that it is authoritative—experts have checked the facts. This is unlike some other recent works whose authors appear not to have taken the trouble to check their information with specialists.

The *Fieldbook of natural history* represents another major contribution from the splendid Cornell group of scientific leaders among whom the Comstocks, Needham, Bailey, the Wrights, Allen, and Hamilton are included. The volume is a great credit, both to the author and to the publishers. Furthermore, the reviewer cannot forbear to mention the price. Five dollars for this book of 664 pages is not only astonishing, but gratifying. The job is a public service which ought to be appreciated by all and will be by many.

W. P. TAYLOR

Stillwater, Oklahoma

Theory of oscillations. A. A. Andronow and C. E. Chaikin. (Solomon Lefschetz, ed.) Princeton, N. J.: Princeton Univ. Press, 1949. Pp. ix + 358. (Illustrated.) $6.00.

The original version of this book was published in Russian in 1937, and parts of it were included in Minorsky's *Introduction to non-linear mechanics*, first published in the David Taylor Model Basin Reports during the war. It is concerned with oscillations in autonomous systems, in particular systems representable by equations of the form

$$(1) \qquad \dot{x} = P(x, y), \; \dot{y} = Q(x, y),$$

including the second order equation $\ddot{x} + x = \mu f(x, \dot{x})$, which is reduced to (1) by putting $\dot{x} = y$. These equations are treated mainly by considering the path of the representative point in the x, y or *phase* plane, using the Poincaré-Bendiron theory of singular points and limit cycles; some graphical methods and the van der Pol and Poincaré methods of approximation are also included. The first chapter introduces some of the main ideas by means of linear oscillations, but the rest of the book is devoted to the nonlinear theory. There are many examples taken from electrical and mechanical systems.

The authors here, and even more in the original, seem to be interested primarily in obtaining geometrical configurations, secondarily in the stability of electric circuits and mechanical systems, and comparatively little in accurate quantitative estimates for periods and amplitudes. We must be grateful to the editor for condensing the mathematical machinery, which goes much beyond possible applications. So far as I can see, from a very brief glance at the original, considerable sections have been rewritten, and the notation has been clarified in many places. The supplement with the oscillographs shown in Minorsky has been omitted, the introduction has been drastically cut and also the list of references, although it contains some new ones. Appendices B and C contain material from other sources, but the proof in B does not cover such a long time interval as the one it replaces.

Mary L. Cartwright
Girton College, Cambridge, England

Venins de serpents et antivenins. (Collection de l'Institut Pasteur.) P. Bocquet. Paris: Flammarion, 1948. 157 pp.

This book offers the reviewer a fine opportunity to make philosophical observations about biological phenomena, and biological observations about philosophical phenomena. Reading the first chapter, which briefly reviews facts that are common knowledge, one wonders how the snake came to be both dreaded and worshiped. It had fundamental significance in mythology and religion, it has been linked with death and immortality, and it was made the symbol of the eternal striving of mankind to explain itself. On the other hand, one wonders about what sort of vagaries and intricacies in the evolutionary process joined in the salivary secretions of snakes substances endowed with such powerful physiological and pathological effects—effects studied by specialists in fields ranging from neurophysiology to acute, invasive infection.

The obvious truth that a thorough analysis of any biological phenomenon must of necessity take a student from his own specialized field into broader and more fundamental spheres seems to find its clearest example in snake venoms, which are a challenge to limitation, and an invitation to universality in biological thought. This is, no doubt, the reason why such illustrious names as Claude Bernard, Delezenne, Weir Mitchell, Calmette, and Arthus are associated with the history of research on snake venoms, and this is why in our days venoms are assiduously studied by penetrating minds. It looks, indeed, as if the amazing properties of snake venoms had the same fascinating effect on the mind of the modern biologist as they had on the mind of the primitive man.

There was an urgent need for a book such as the one written by P. Bocquet, because those published in the past by Calmette and Physalix in France, Noguchi in the United States, Belfanti and Fracassini in Italy, Picado in Costa Rica, and still others, valuable as they are, are now dated. The book, which can be read in a few hours, is divided into 14 chapters. The first chapter offers pertinent historical data; the next four chapters deal with the toxic secretions in the animal scale, anatomy and function of the poison glands, and the natural and experimental poisoning. The sixth chapter, which is the longest, reviews first the effects of venoms on the nervous, muscular, and circulatory system, on the blood, and on cells and tissues. Then it analyzes the varied enzymatic content in the poisonous secretions, and finally it studies the action of different venoms on microorganisms, vegetal cells, and enzymes. The three following chapters consider the effects of physical and chemical agents on venoms, the chemical constitution of venoms, and variations in their toxicity, as depending on geographical and seasonal factors. The tenth chapter deals with the classification of the venoms. The last four chapters are concerned with problems of natural and acquired immunity, and the preparation of antipoisonous sera; with treatment of snake bite; and finally, with the therapeutic applications of snake venoms. The many subjects approached are treated in an authoritative manner and with characteristic French clarity. The author discusses the effects of snake venoms on the nervous, circulatory, digestive or respiratory system with perfect mastery of the sciences of physiology and pharmacology, and his classification of venoms in relation to other toxins, enzymes, and poisons shows an excellent knowledge of toxicology and bacteriology. Also, his analysis of the phenomena of natural and acquired immunity reveals a solid background in immunology, as do the precise directions for the preparation of efficient antivenimous sera.

To understand how the author, still a young man, could have accomplished his task as successfully as he did, one must remember that he has lived all his life in the atmosphere of the Pasteur Institute of Paris. Paul Bocquet is the son of an illustrious Pasteurian, Alfred Bocquet, to whom the book is dedicated and who, in turn, was the closest collaboratory of A. Calmette, the head of the brilliant School of Tuberculosis of the Pasteur Institute, and the discoverer, more than forty years ago, of the antiophidean serum-therapy. The author is himself the present head of this department at the Pasteur Institute. Bordet, still another brilliant member of Pasteur's school, reminds the reader of all these circumstances in the foreword he has written for the book.

This book, therefore, besides being the expression of an individual effort, is an exponent of continuity of one of the most brilliant schools in biological thought of the last seventy years. Bocquet's name is to be ranged with the names of so many other workers of the present Pasteur Institute who indefatigably persevere along a great tradition despite almost overwhelming financial odds and political events too recent to need recounting.

F. Duran-Reynals
Yale University School of Medicine

NEWS and Notes

C. Lovatt Evans will retire this summer from his position as Jodrell Professor of Physiology, University College, London, which he has held since 1926. His publications include a series of *Recent Advances in Physiology* and a textbook on human physiology. Since the death of E. H. Starling Dr. Evans has edited Starling's *Principles of Physiology*, now in its tenth edition.

N. Ercoli, director of biological research at the Warner Institute for Therapeutic Research, New York City, will assume the direction of the Istituto Sieroterapico Milanese, Milan, Italy, in September.

E. S. Moore, head of the Department of Geological Sciences, University of Toronto, retired June 30 with the title professor emeritus, after 27 years on the staff.

Donald Woernley, physicist with the American Optical Company, has joined the staff of the Roswell Park Memorial Institute, Buffalo, New York, where he will conduct research in cancer biophysics.

Milton V. Veldee, chief of the Public Health Service's laboratory of biologics control, will retire after nearly 30 years of service with the agency. Dr. Veldee will be succeeded by his assistant, **William G. Workman**, who has been with the National Institutes of Health for the past 18 years.

G. M. Watkins, mycologist at the U. S. Naval Ordnance Laboratory, has been appointed professor of plant pathology in the Department of Plant Physiology and Pathology at Texas Agricultural and Mechanical College.

J. Eldred Hedrick, senior technologist of the Shell Chemical Corporation, has been appointed a professor of chemical engineering at Cornell University, effective this month.

Ismael Vélez, professor of botany at the Polytechnic Institute of Puerto Rico, will conduct research during 1949–50 on the herbaceous vegetation of the Caribbean Archipelago under a Guggenheim fellowship. During the year, Dr. Vélez will visit the herbaria of Washington, D. C., New York, and Chicago.

Grants and Awards

The National Institutes of Health Division of Research Grants and Fellowships is being reorganized. A new section on arthritis and rheumatism has been established and another on morphology and genetics; the sections on antibiotics, tuberculosis, and syphilis have been merged into a single section on experimental therapeutics; the panel on malaria has been abolished and its functions will be taken over by the tropical medicine section; the bacteriology section will now be known as the section on microbiology and immunology, and the sanitation study section as environmental health. The study section on gerontology has been discontinued because so few applications for grants were received, and the radiobiology section is no longer necessary since most radiobiology applications now go to the Atomic Energy Commission. The sections, whose members meet periodically to consider applications for research grants-in-aid, have been reduced in number from 20 to 17. *August 1* is the deadline for applications to be considered at September–October meetings of the sections; *December 1* for January–February meetings, and *April 1* for the May–June meetings.

The American Academy of Arts and Sciences announces that income from its Permanent Science Fund will be disbursed as grants-in-aid in support of research projects, which may be in any field of science.

Requests for further information about conditions governing the grants should be addressed to Hudson Hoagland, Chairman, Permanent Science Fund Committee, Worcester Foundation for Experimental Biology, 222 Maple Avenue, Shrewsbury, Massachusetts. Applications will be considered on *March 1* and *October 1* of each year.

The Research Corporation has announced the recent distribution of grants-in-aid for scientific research amounting to $235,000 for the initiation and continuation of 64 research projects administered by colleges, universities, and scientific institutions in the U. S. This brings the year's total of grants to $650,000, for a range of projects including cosmic ray research, construction of a mass spectrometer, studies of the structure if proteins, total synthesis of morphine, photochemical reactions, electrodeposition of metals, and various studies of metal alloys.

Colleges and Universities

Purdue University's new Department of Biological Sciences, which replaces the former Department of Biology, includes three major divisions: bacteriology, botany, and zoology and animal husbandry. John S. Karling, formerly of Columbia University, is head of the department and P. A. Tetrault, A. T. Guard, and C. J. Goodnight, respectively, are chairmen of the divisions. M. X. Zarrow, of Harvard University, and Dorothy M. Powelson, of the University of Maine, have been appointed professors of endocrinology and bacteriology, respectively, effective July 1st. A fourth division of biophysics is being organized jointly with the Department of Physics and will be under the direction of Lorin J. Mullins of Johns Hopkins University, who has been appointed professor of biophysics.

The Institute of Science and Technology of the University of Arkansas will conduct research on a contract basis for the Atomic Energy Commission on the chemical effects of nuclear transformations. The contract consideration for the first year is $25,000. Under the contract, an effort will be made to utilize hot atom exchange reactions in the preparation of tracer compounds, particularly those useful in medical and biological research. The project will also include a study of the chemical effects of beta decay processes. Raymond R. Edwards, associate chemist in charge of nuclear studies in the institute, will head the project and will be assisted by Paul L. Day and John R. Totter of the School of Medicine's Department of Biochemistry.

Smith College announces receipt of a grant from the National Cancer Institute of the U. S. Public Health Service in support of the studies being carried on by the Smith College Genetics Experiment Station on ovular tumors, which prevent wide species crosses. The Genetics Experiment Station, established in 1942, has given M.A. degrees to seven graduate students and Ph.D. degrees to three. Through grants from other foundations it has been carrying on research and graduate instruction in plant cytogenetics, methods of embryo culture, and other controls of evolution and life processes in plants, with special reference to horticultural practice. The scientific staff consists of Albert F. Blakeslee, director, Sophie Satin, assistant director, Amos G. Avery, associate geneticist, and Jacob Rappaport, plant physiologist.

Young women with a bachelor degree who desire to work in the Genetics Experiment Station toward an advanced degree should apply to the Director, Smith College, Northampton, Massachusetts. For the coming academic year there are available one full-time assistantship at $2,000 and two part-time graduate assistantships at $1,000, plus tuition. Opportunities are available for apprentice training in plant breeding with academic credit during the summer.

The **California Institute of Technology** is planning construction of a new earthquake-resistant, concrete-reinforced engineering laboratory, at a total cost of approximately $625,000 when equipped. All of the civil engineering section will be moved to the new building, which will also house laboratories for such projects as powder metallurgy, X-ray metallography, spectrographic analysis, metals preparations, and use of radioactive isotopes in the study of materials. There will be a thermodynamics laboratory, one for strength and materials research, another for earthquake studies and for vibration investigations, and space for offices and classrooms.

Meetings and Elections

Science Abstracting. Over 1,850,000 scientific articles are published each year throughout the world. Only one-third of them are abstracted and thus made available in convenient form for a wide audience of scientists. These are abstracted, on the average, three times; the rest are not abstracted at all. The International Conference on Science Abstracting was convened by the Department of Natural Sciences of Unesco to examine this situation and consider what could be done to improve it.

Under the able chairmanship of Alexander King, of Great Britain, and with the efficient organizational technique of J. B. Reid, Unesco's Program Specialist for Scientific Literature, the conference met in Paris June 20–25. There were present 62 voting delegates from 28 countries and 24 international scientific organizations, together with 85 observers, making a total of 147 representatives from 29 countries.

The resolutions adopted in the final plenary session of the conference include many items of considerable significance to the advance of science in coming years. As would be expected, it was recommended that Unesco continue its efforts to promote the free interchange of scientific literature among the different countries, inasmuch as the complete coverage by abstracts of all new scientific information depends on that freedom. To facilitate the use of foreign literature in each country, it was recommended that adequate bilingual or polyglot dictionaries should be provided for all fields of science and technology, taking into account the national variations in usage and, if possible, making use of illustrations.

The secretariat of Unesco was urged to promote, in collaboration with the international scientific unions or other appropriate bodies, the standardization of scientific terminology and the publication at appropriate intervals of lists of new terms, with translations in various languages. Especially, in view of the urgent need for detailed evalution of the various systems proposed for chemical notation, the conference voted that the International Union of Chemistry and other organizations concerned with that problem be notified of the importance attached to it by the conference. The members were thinking not only of the primary use of symbols and words in recording data but also of their applications to the indexing of abstracts. Throughout many a discussion, one would recognize the general eagerness for more comprehensive standardization of terminology and publication procedures.

Several good suggestions were directed at the editors of scientific journals. It was agreed that each issue of such journals should include synopses of all its original articles. These should be in English or French, if not also in other languages, and the editor should accept responsibility for their adequacy, whether or not prepared by the author. The *Guide for the preparation of synopses*, prepared by the Abstracting Services Consultative Committee and issued by the Royal Society, Burlington House, London, was suggested as a basis for a standard guide that should be prepared for the use of authors and editors. Further, it was recommended that if a paper is not the publication of an original work, editorial symbols should be used to indicate whether it is a review, a discussion or criticism of previously published work, or a technological application of basis data. Most important of all, there was a strong expression of hope that synopses would be made freely available for republication by abstracting services in spite of copyright provisions of original journals.

Attention was directed toward the desirability of the establishment of regional bibliographical centers with facilities that would be used in locating periodicals, books, theses and laboratory reports obtainable within the region. The hope was also expressed that such centers be equipped for the production and distribution of photocopies, either full scale or microfilm. Scientists and scientific publishing bodies may find it desirable to set up, in cooperation with national or regional committees, subject committees on an international level to coordinate abstracting in such major fields of pure and applied science as physics, chemistry, mathematics, engineering, and agriculture. Unesco was therefore asked to invite appropriate international organizations, such as the several international scientific unions, to facilitate the formation of these subject committees and their liaison with each other.

In keeping with the well-known objectives of Unesco, the conference consistently aimed toward coordination and cooperation between the numerous bodies now concerned with science abstracting, and the extension of their activities within the broad domain of science and technology. But most significantly, its findings and recommendations were also directed toward a much more complete geographical coverage in order that the results of research and development might be far more widely distributed and shared than at present. There seems little doubt but that the holding of this conference marks a long step forward toward that objective.

KIRTLEY F. MATHER

The Central States Section of the Botanical Society of America, which is holding its summer meeting jointly with the Northeastern Section in Ann Arbor, Michigan, has scheduled an important business meeting in Rackham Amphitheatre, University of Michigan, at 2:00 p.m., August 20th. This is the first meeting of the newly organized Central States Section and all members are urged to attend.

The American Institute of Electrical Engineers will hold its Pacific General Meeting in San Francisco August 23–26, with headquarters at the Fairmont Hotel. The meeting will be opened at 10:00 a.m., August 23 by George C. Tenney, chairman, followed by a general session with W. C. Mullendore as speaker. Reprints of technical papers may be obtained by writing to the AIEE Order Department, 33 West 39th Street, New York City 18. The uniform price per paper is 30 cents to members and 60 cents to nonmembers. Advance registration may be made through R. O. Brosemer, Chairman, Hotel Committee, 447 Sutter Street, San Francisco 8, California.

The American Chemical Society will hold its 116th national meeting in Atlantic City, New Jersey, September 18–23. Ten thousand chemists and chemical engineers are expected to take part. Titanium, the flame-proofing of textiles, the development of new and safer insecticides, and recent discoveries concerning the nutritional value of vitamin B-12 are among the subjects to be discussed. E. J. Cohn, of Harvard University, will preside at a biological division meeting on protein interactions. J. G. Reinhold, of the Philadelphia General Hospital, will be chairman of a symposium on clinical biochemistry. The Cellulose Division will cooperate with the National Research Council in a symposium on the degradation of cellulose, dealing with research which has produced a bandage for internal use which can be absorbed by the body.

Security clearance of scientists for secret work on atomic energy will receive special consideration. A symposium on security clearance will be held under the auspices of the society's Division of Industrial and Engineering Chemistry, with Wayne W. Hilty, head of the Committee on Professional Relations and Status, as chairman. Spokesmen for the Atomic Energy Commission, the National Military Establishment, private industry, and individual scientists who have had personal experience with existing security regulations will participate.

A colloquium on the mechanism of carbon combustion will be held in Nancy, France, September 27–30, under the sponsorship of Centre National de la Recherche Scientifique. Lother Meyer, of the University of Chicago's Institute of Metals, has been invited to participate. There will be eight participants from England, one from Belgium, and three from France.

A Southeast Asia and Pacific phytosanitary convention was agreed upon at an international conference held April 26–28 in Singapore, on invitation of the British Commissioner General. Some 13 nations or territories of the region were represented, as well as the Food and Agriculture Organization and the South Pacific Commission.

The agreement, which will now be submitted for ratification by all governments of the region, proposes uniform plant quarantine laws and regulations for controlling traffic in living plants and plant products to prevent introduction and spread of new insect pests and dangerous plant diseases. Increasing air travel and commerce have accentuated the danger of introduction of South American leaf blight of rubber and diseases and pests of other crops into Southeast Asia, as well as the introduction of the swollen shoot virus of cacao and related plants from Africa. The agreement is patterned after a similar one, formulated in 1948 in London, to include all of Africa south of the Sahara.

At the 47th annual meeting of the **American Neurological Association** held in Atlantic City, the following officers were elected for the year 1949–50: president, Henry W. Woltman; first vice president, Johannes M. Nielsen; second vice president, E. Jefferson Browder; secretary-treasurer, H. Houston Merritt; and assistant secretary, Charles Rupp.

The Michigan Academy of Science, Arts and Letters at its 53rd annual convention elected the following officers for the ensuing year: president, Paul S. Welch, University of Michigan; vice president, E. C. Beck, Central Michigan College of Education; secretary, Frederick H. Test, University of Michigan; treasurer, James L. Wilson, University of Michigan; and editor, Frederick K. Sparrow, University of Michigan.

On recommendaton of the society's Committee for Promotion of Research, the research grant from the AAAS was divided among the following persons: A. M. Chickering, Albion College, for a continuation of his studies of Panamanian spiders; Dale J. Hagenah, Detroit, to aid in preparation of a bibliography of Michigan botany; William Hovanitz, Wayne University, to aid the analysis of populations in Colias butterflies; Volney H. Jones, University of Michigan, for help in field investigations among the Huasteca Indians of Mexico.

The 68th Congress of the Association Francaise pour l'Advancement des Sciences was held at Clermont-Ferrand, Auvergne, France, July 15–21. The inaugural exercises were held in the Municipal Theatre at 10 a.m. Friday July 15 with the mayor of Clermont welcoming the members and guests. At 2:30 the same day the presidents and secretaries of the 26 sections of the association announced the titles of the papers which had been submitted for inclusion in the programs of the separate groups and the sequence of presentation. The section meetings were arranged to avoid conflicts with general papers presented before the congress as a whole. The unusual geological formation of the local area quite naturally afforded an opportunity for a very strong program in this discipline. In addition, there were a number of excursions and field trips of special interest. The total registration was over 350. Malcolm H. Soule, University of Michigan bacteriologist, who was the delegate of the AAAS, was given a medal at the closing session on Thursday, July 21. The 69th congress of the association will be held in Toulouse in late September, 1950.

Deaths

Aristide Fanti, 81, scientific librarian of the National Bureau of Standards from 1910 to 1938, died April 5 in Cheverly, Maryland, after a brief illness. Dr. Fanti contributed largely to the development of an international auxiliary language known as Interlingua.

O. F. Cook, 81, retired botanist of the U. S. Department of Agriculture, died April 23 at his home at Lanham, Maryland. Dr. Cook developed the single-stalk method of cotton culture which is used universally in the U. S. cotton belt.

Otis Freeman Curtis, 61, professor of botany at Cornell University and a member of the Cornell faculty since 1915, died July 4 while vacationing at Chatham, Massachusetts. Dr. Curtis was at one time president of the American Society of Plant Physiologists and was author of several plant physiology textbooks.

William Gerry Morgan, 81, professor of diseases of the digestive tract at Georgetown University since 1904 and its school of medicine from 1931 to 1935, died July 7 of a heart attack in Washington, D. C. Dr. Morgan was a former president of the American Medical Association and a master of the American College of Physicians.

Edward B. Stephenson, 67, superintendent of the Mechanics Division of the Naval Research Laboratory, died of a heart attack May 6 in San Francisco. Dr. Stephenson received a Navy award in 1931 for developing the use of American quartz crystals in underwater sound-detecting devices.

Cosmic ray activity at 20-mile altitudes will be studied next month by an expedition sponsored by the National Geographic Society, Washington, D. C., and the Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania. The study will be made at the Canadian outpost settlement of Churchill on the shore of Hudson Bay. The program is a continuation of cosmic ray research instituted by the two sponsors and supported by the Air Force and Office of Naval Research. Canada's National Defense Board is cooperating in the undertaking. Martin A. Pomerantz, of the Bartol Foundation, will head the expedition, which leaves August 1. He hopes to develop evidence as to whether the sun is surrounded by a constant magnetic field similar to that of the earth.

Processing of quartz crystals to eliminate deterioration by age has been developed by the Army Signal Corps and is expected to benefit all types of communication, especially radio broadcasting, television, radar, Loran, and guided missile control. Blank crystals are placed on a conveyor belt and drawn through an electrically heated oven for two or three hours, reaching a temperature of 900° F, and then subjected to controlled cooling for 24 hours. The new process is credited to Arthur C. Pritchard, Maurice A. A. Druesne, and David G. McCaa, of the Frequency Control Branch of the Signal Corps Engineering Laboratories at Fort Monmouth, New Jersey.

The Philadelphia General Hospital announces the establishment of a nutrition clinic which, with its research laboratory, will study various nutritional problems among the patients in the hospital and Philadelphia school children. The laboratory is supported by grants-in-aid from Swift and Company and the National Live Stock and Meat Board for studies on the relation of diet to immunity, with particular reference to the effect of meat supplementation to antibody formation. Michael G. Wohl, associate professor of medicine, Temple University School of Medicine, will be chief of this clinic and Katherine Langwell, professor of nutrition at Drexel Institute, will act as nutritionist.

Unified Screw Thread Standards, Circular 479, recently published by the National Bureau of Standards, is now available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C., at 30 cents a copy. The booklet contains the proceedings of the meeting which resulted in the unification of American, British, and Canadian standard systems of screw threads, (see *Science*, April 1, 1949, p. 346), and includes detailed illustrations, tables, and numerical data. Remittances from foreign countries must be in U. S. exchange and must include one-third the publication price to cover mailing costs.

Make Plans for—

American Mathematical Society, August 30–September 2, 55th summer meeting in conjunction with summer meetings of Econometric Society, Institute of Mathematical Statistics, and Mathematical Association of America, University of Colorado, Boulder.

American Institute of Chemical Engineers, regional meeting, September 6–8, Montreal, Canada.

Scientists, Scientific Societies, and the Armed Forces

Herman S. Wigodsky

Silver Spring, Maryland

THE RECENT PUBLICATION by the Department of the Army of the booklet *Scientists in uniform, World War II* was followed by a small flurry of editorial comment. Although the booklet was published by the Army, it is based on data obtained from scientists who had served in all branches of the armed forces. This renewed interest in the problem of the scientist's place in the National Military Establishment apparently was short-lived and resulted in no really significant action either on the part of the military or on the part of science. It is difficult to understand the apparent disregard of this critical summary of the experiences of a great number of scientists, which offered many lessons. These experiences should inspire an intensive effort to correct what are apparently self-admitted deficiencies. By this time, however, it is evident that the effort will not arise spontaneously within the armed services. If it is to be made, the effort will have to come from those scientists who provided the material on which the booklet was based, acting together with their fellow scientists, both as individuals and through their collective media—the scientific societies.

Is this problem important enough to warrant some concerted action on the part of scientists? The evidence indicates that such action is not only desirable but actually fundamental to successful national defense. Even the layman saw how dependent the armed services were upon scientific advances during the war. Now that the war is over new weapons are still essential to successful national defense, and only scientific research can produce them. Many more facts point up the importance of good relations between science and the military. We have a large military establishment, which is continuing its warborn policy of supporting research. This country is assuming increased international responsibilities. In the event of another war an attack on the continental areas of the United States is almost certain. These are all reasons for establishing an efficient scientific organization within the services.

One might well inquire next whether science would be justified in attempting to establish within the armed services those conditions that are so well recognized as being essential to fruitful research. In this connection, the scientist should bear in mind that he has a dual responsibility, the first being his responsibility as a citizen of the United States, and the second his acknowledged indispensability in the development and application of new weapons, techniques, and operational methods. In answer to this inquiry, it cannot be overemphasized that the armed forces are the stewards of the people in regard to military affairs. The services are under civilian control, as has been well demonstrated. It therefore becomes a duty of every citizen, and particularly of every scientist, not only to support the armed services but also to scrutinize their actions, criticize where necessary, present constructive suggestions as needed, and finally to determine whether these suggestions have been adopted. What section of the citizenry is better qualified to carry out these duties, where scientific policies are involved, than the scientific segment?

Once the importance of the problem of science in the armed services is established, and the duty of the scientist in regard to the problem, two more questions present themselves. First, are the military services dealing adequately with this problem? Second, is organized science taking sufficient interest in the actions of the military services?

In answering the first question, one must remember that, in peacetime, the primary mission of the armed services is to prepare for the defense of the nation in the event of war. As has been stated, these preparations must depend upon scientific research to develop and to assist in the application of new weapons, techniques, and operational methods. In order to coordinate the scientific efforts of the National Military Establishment, Congress established the Research and Development Board. The Board's functions are limited to surveying fields of interest to the military for pertinent scientific discoveries, and to coordinating research so as to minimize duplication. Unfortunately, the board's authority does not extend to such major responsibilities as selection of scientists, operation of laboratories, establishment of operating policies, planning careers in science, or publication of research. It is difficult to see how the Research and Development Board can ever be completely successful until these duties are assigned to some section of the Military Establishment and are put on an equal basis with the ones now performed by the RDB. Clearly, there is not now in the Military Establishment any central group discharging these responsibilities.

Although the necessity for establishing such authority was pointed out on numerous occasions before the end of the war, no action was taken. There was widespread dissatisfaction with the place of the scientist in the military at that time, as reflected in the the booklet, *Scientists in uniform, World War II.* Testimony to the strength of this dissatisfaction is presented by the precipitous decrease in the number of scientists in the services after V-J Day, in spite of well-equipped laboratories and good salaries. Apparently little has been done to remedy conditions responsible for this dissatisfaction and certainly scientists outside the services have done nothing toward solving the problem.

A few quotations from *Scientists in uniform, World War II* will illustrate the type of problem under discussion and the failure of the armed services to correct the apparent defects: Page 61: "More than one-half of the respondents emphasized the need for better methods of assignment or supervision of technical personnel in uniform. The emphasis varied from 80 percent of the respondents in the field of biology to 35 percent in the fields of geology and psychology." The number of respondents are: biology 2,830; geology 605; psychology 1,168. The percent reporting utilization in primary field and at proper level of competence for at least half or more of the time in military service are respectively 34, 27, and 72 percent. Page 13: A chart presents the information that 63.2 percent of the respondents suggested better assignment or supervision. Page 16: "Scientists trained in technical fields whose uses were not thoroughly understood by personnel of the Armed Services tended to be poorly utilized, the opposite was generally true for scientists representing technologies with which the services were familiar. . . . Failure to understand the application of many technical fields to military functions led to a lower efficiency of technical military activities and an inability of scientists to carry projects through to active military application."

These several quotations all refer to assignment and supervision of scientists, and without doubt, these are key factors in the successful utilization of scientists in the services. With the exception of certain of the civilians on the Research and Development Board, however, none of the top rank positions within the three armed services is held by an outstanding scientist. On the contrary, many are held by military men who are poorly trained in science, some of them with no training in science at all. This same condition extends downward to the level of laboratories and other working facilities. Some of them are sympathetic with the scientists' problems, but the point is that they are not scientifically competent. There are of course exceptions—a few conscientious, competent scientists in various echelons who are doing an excellent job, in spite of difficulties, and who deserve praise and encouragement.

From this and other evidence, such as the failure to establish a section to deal with scientists in the newly appointed Secretary of National Defense's Personnel Board, one is led to believe that the National Military Establishment is not dealing adequately with the problem of science and the scientist in the armed services. One even suspects that scientific possibilities are not fully pursued and that the best efforts of the Research and Development Board must be nullified within the services themselves.

Turning to the second question—whether organized science is taking sufficient interest in the actions of the armed services—one must conclude that it is not. Several branches of organized science have appointed advisory committees to the Department of the Army in recent months, but only at the invitation of the Department, and no such committees have yet waited upon the Secretary of National Defense.

As in prewar years, it has become unfashionable to discuss such matters at scientific meetings. Postwar problems have completely overshadowed them, although they had immediate and personal importance to many scientists who served in the armed services. It is difficult to understand why organized science has not maintained greater interest in problems so important to national defense. Unless the situation is corrected in peacetime, scientists will be faced with the same problems in the next war.

Not only is there apparently great reluctance on the part of organized science to attempt to correct the military situation, but also there is increasing reluctance to accept from the armed services any research contracts that have a security classification. Recently, the president of a leading university stated definitely that his university would not accept such contracts in the future. This attitude has found many adherents and will find many more. I will neither attack nor defend this position, although it is my opinion that research on classified projects in academic institutions is incompatible with academic and scientific ethics. The fact remains, however, that this attitude by academicians, scientists included, only increases their responsibility to see that the armed services are provided with the personnel and facilities necessary to carry out research themselves.

Realizing the failure or inability of the military services to solve the problem properly, and the failure of organized science to insist on a proper solution, one cannot help but be concerned about the situation. There is ample evidence at hand that the services will not take the necessary action of their own volition. This leaves but one course of action—organized science must reawaken its interest in the military problem. The medical profession, having failed to take similar action in the face of a parallel and long-standing problem, are now faced with a draft. Will a similar crisis be required to stimulate scientists?

In answer to the question, "What can be done?" I make the following suggestions:

1. Committees can be organized within scientific societies to make a thorough investigation of the role of the scientist and science in the armed forces.
2. The services of these committees can be offered to the Secretary of National Defense to investigate the problem and to make necessary recommendations.
3. Standing committees can be established to provide periodic resurveys and to assist in (or to insist upon) the correction of obvious defects.
4. A mechanism can be established whereby scientific societies and academic institutions may assist the armed forces in obtaining necessary scientific personnel of sufficiently high caliber to meet the needs.
5. A plan for determining the supply of scientific man power in the United States and for using it in time of national emergency can be developed and presented to the President of the United States.

These suggestions are only a few of the many that could be made. Unless scientists take action on these or other suggestions which will aid in resolving this important problem, they will have failed to discharge a public duty and to exercise an important right of citizenship. The costs of such failure will be made clear in the event of a national emergency—a time for implementation of plans, not their preparation, and for use of weapons, not their development.

Infrared Spectra of Tissues

Elkan R. Blout and Robert C. Mellors[1, 2]

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THE INFRARED SPECTRA of many substances such as proteins (*1, 5, 8*), amino acids (*7, 9*), and nucleic acids (*2, 3*) extractable from tissue have been determined. The purpose of the present investigation is to examine the infrared transmission of whole tissue sections of various types with a view toward comparing the data. In this paper we are reporting some measurements of the infrared spectra of tissue sections and blood smears.

The technique used for determination of the spectra consists of mounting the tissue sections (4 to 50 μ thick) directly on thin (0.060-in.) disks of silver chloride without the use of cover slips. If paraffin sections are used, the paraffin is removed by immersion in xylene and washing two or three times in absolute alcohol. A drop of oil is then placed on the section and spread as evenly as possible over it before measuring the spectrum. The use of such a liquid is desirable in order to reduce scattering by the tissue, especially at wavelengths shorter than about 5 μ. A high molecular weight liquid fluorocarbon[3] has been found useful for wavelengths between 1 and 7.3 μ, since thin layers of it are completely transparent in this region. For the portion of the spectrum between 7.3 and 15 μ a hydrocarbon (mineral) oil is satisfactory in spite of its slight absorption at 13.8 μ. In all measurements a comparison silver chloride disk coated with approximately the same thickness of oil is used. The tissue section adheres strongly to the silver chloride through these manipulations, and is then ready for measurement in the spectrometer. We use a Perkin-Elmer instrument (model 12A) and place the sample close to the slit. Because the sample is not placed directly at the slit, it is desirable that the tissue area selected for measurement be approximately 17 by 5 mm (slightly larger than the slit size).

In all the spectra shown in Figs. 1–5 there are several strong absorption bands which may be correlated with those of known chemical groupings, viz., 3.04 μ (3290 cm^{-1}), N-H stretching; 3.4 μ (2940 cm^{-1}),

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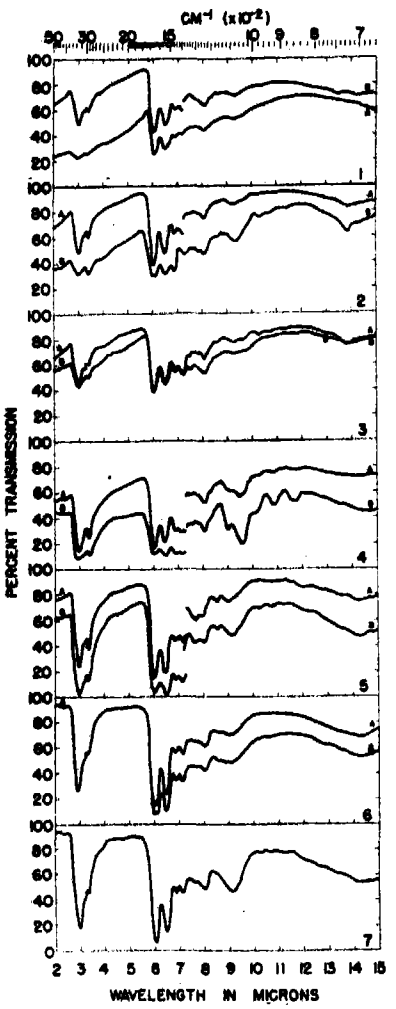
[1] This work was done in part under a fellowship grant to one of us (R. C. M.) of the American Cancer Society.

[2] We are indebted to Miss A. P. Sutton for technical assistance, to Dr. K. G. Stern of Brooklyn Polytechnic Institute for the histone sample, and to Dr. M. Pechet of Children's Hospital for the leukemic blood smear.

[3] Perfluoro lube oil (E. I. du Pont de Nemours & Co.), bp 130–160° C/10 mm, n_D^{20} 1.335. The relatively low refractive index is a disadvantage.



FIGS. 1–7. Infrared spectra of tissues. 1—Carcinoma of bladder, 18-μ section, formalin-fixed paraffin-imbedded. Curve A, section with the paraffin removed; curve B, section obtained with the addition of a drop or two of the proper oil. The reduction in scattered light with consequent better definition of the absorption bands, especially at short wavelengths, is apparent. 2—Human mammary carcinoma, formalin-fixed. Curve A, 10-μ section; curve B, 50-μ section. 3—Curve A, human mammary fibroadenoma, formalin-fixed, 20-μ section; curve B, normal human breast, formalin-fixed, 20-μ section. 4—Human mammary carcinoma, fresh frozen, dehydrated tissue. Curve A, 20-μ section; curve B, 50-μ section. 5—Human peripheral blood smears, air-dried. Curve A, normal; curve B, acute leukemia. 6—Histone. Continuous film on silver chloride. 7—Ribonuclease. Continuous film on silver chloride.

C-H stretching; 6.00 μ (1670 cm^{-1}), C-O stretching; 6.52 μ (1535 cm^{-1}), amide bending; and 6.88 μ (1450 cm^{-1}, C-H bending. The consistent appearance, except in the frozen, dehydrated sections, of a slight inflection point at 3.26 μ (3070 cm^{-1}) indicates that it may be the N-H band recently pointed out by Sutherland (*1*) in certain polypeptides. In addition a band at 8.06 μ (1241 cm^{-1}) to which a definite assignment has not been made, is apparent in all the spectra. The presence of these bands suggests that the main absorbing constituent is protein in nature; and comparison of the spectra of the tissue sections with that of a histone film (Fig. 6) and a film of ribonuclease (Fig. 7) shows correspondence of the strong bands. The infrared spectra of other proteins from animal and fish sources show similarity in the bands at wavelengths shorter than 6.6 μ, but divergence at longer wavelengths.

In general it is at wavelengths longer than 7 μ that differences due to composition, and to different proportions or arrangements of component groups, should appear. For example, the band at 9.20–9.35 μ seen in all the fixed tissue sections does not appear in the blood smears, whereas two bands apparent in the blood spectra at 8.55 and 9.05–9.15 μ are absent from the tissue curves. Whether the shift of the 9.05-μ band in the normal blood smear to 9.15 μ in the leukemic blood smear is significant is not known at present. Another point that is worthy of note in the spectra is the increased intensity of the 9.3-μ band in the cancerous mammary tissue in Fig. 2 (out of proportion to thickness) as compared with the normal breast tissue (Fig. 3). This band lies at the same position as one of the strong ones in the nucleic acid spectra (*3*), and it is probable that this increase in absorption is due to an increased amount of nucleic acids in the rapidly proliferating and more cellular carcinoma. Of particular interest is a comparison of the infrared spectra of fixed (lipid-extracted) tissue with fresh frozen, dehydrated tissue. This comparison is perhaps best made between curves 2B and 4B, which are spectra of 50-μ sections of human breast carcinoma. Several absorption bands which appear in the frozen section at 9.00 μ (1111 cm^{-1}), 10.85 μ (922 cm^{-1}), and a doublet at 11.60–11.75 μ (862–851 cm^{-1}) do not seem to have counterparts in the fixed tissue spectra. Also the strong band at 9.55 μ (1047 cm^{-1}) in curve 4B appears to be shifted toward longer wavelengths, if indeed it is the same band (9.20–9.35 μ) seen in the fixed tissue sections.

It is hoped that with the increasing availability of reflecting microscope lenses of the Burch (*4*) and Grey (*6*) types, the infrared study of tissues can be extended to cells and portions of cells. Whether infrared techniques will allow an exact differentiation and identification of tissues must await further work.

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TECHNICAL PAPERS

The Effect of Vitamin B_{12} Concentrate on the Growth of Weanling Pigs Fed Corn-Soybean Diets[1]

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In experiments with chicks, Ott, Rickes, and Wood (*2*) have shown that crystalline vitamin B_{12} gave a growth response comparable to that obtained with crude sources of the "animal protein factor." Johnson and Neumann (*1*) have obtained growth stimulation from a vitamin B_{12} concentrate fed to suckling pigs.

The present experiment was undertaken to determine whether crude vitamin B_{12} concentrate exhibited a growth-stimulating effect in weanling pigs fed a diet in which the protein source was entirely of plant origin.

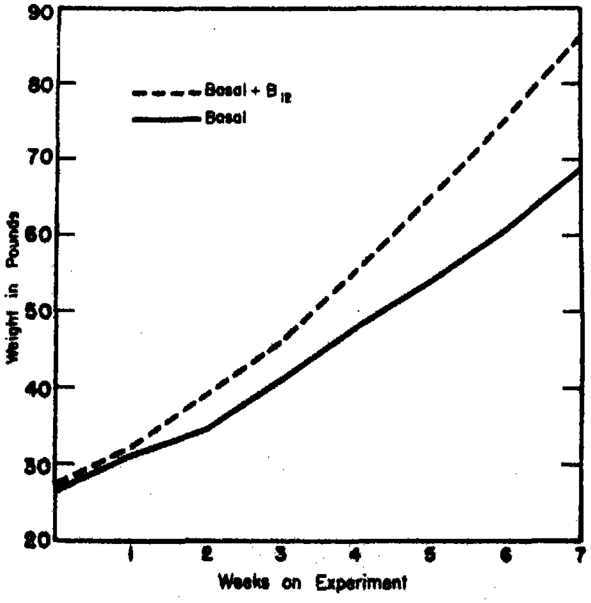

FIG. 1. Effect of vitamin B_{12} concentrate on growth rate.

The pigs used in the experiment were farrowed by Chester White gilts which had never been fed any known source of the "animal protein factor." At the time of weaning, 12 pigs were selected and divided into two lots of six pigs each. The basal ration was the same as that fed to the gilts during their growth, gestation, and lactation period and contained corn, 77%; soybean oil meal, 20%; and a complex mineral mixture, 3%. This ration was supplemented with the following B vitamins expressed in mg per lb of feed: thiamine, 5; riboflavin, 5; calcium pantothenate, 20; niacin, 25; and pyridoxine, 2. Choline chloride was also added at a level of 0.1%. Vitamins A and D were added to the ration in amounts which supplied 2,000 I.U. of vitamin A and 200 I.U. of vitamin D per lb of feed. This ration contained 16.5% crude protein by Kjeldahl analysis. All of the pigs in the experiment were fed *ad libitum*. The pigs in lot 1 were fed the basal ration and their growth response is shown in Fig. 1 and in Table 1. The pigs in lot 1 gained an average of 0.87 lb per day and consumed 2.57 lb of feed. It required 2.94 lb of feed to produce a 1-lb gain in body weight.

TABLE 1

EFFECT OF ADDITION OF VITAMIN B_{12} CONCENTRATE TO A CORN-SOYBEAN DIET

	Lot 1 (Fed basal ration)	Lot 2 (Fed basal ration + vitamin B_{12})
Number of pigs	6	6
Initial age in weeks	6	6
Number of weeks on trial	7	7
Average initial weight (lb)	26	27
Average daily gain (lb)*	0.87 ± .09	1.20 ± .08
Average daily feed consumption (lb)	2.57	3.21
Lb of feed per lb of gain	2.94	2.65

* Difference in average daily gain between lots 1 and 2 is statistically significant.

The pigs in lot 2 were fed the same ration as those in lot 1, but in addition, this ration was supplemented with 0.5% vitamin B_{12} concentrate. The vitamin B_{12} concentrate had been assayed in comparison with crystalline vitamin B_{12} and the preparation standardized to contain 2 mg of vitamin B_{12} activity per lb as measured by the chick-growth method. The growth curve for the pigs in this lot is shown in Fig. 1. It can be seen that as the experiment progressed, the differences in rate of gain between pigs in lots 1 and 2 became significantly greater, and by the end of the seventh week pigs in lot 2 averaged 17 lb heavier than animals in lot 1. Table 1 shows that pigs in lot 2 gained an average of 1.20 lb of body weight and consumed an average of 3.21 lb of feed per day. The animals in lot 2 utilized their feed more efficiently since it only required 2.65 lb of feed to produce a 1-lb gain in body weight as compared with 2.94 lb of feed for pigs in lot 1. From a practical standpoint the growth rate of pigs in lot 2 was excellent, especially since the protein content of the ration is considerably lower than one would recommend for pigs of that age and weight. It seems valid to conclude, therefore, that the significantly greater gains made by pigs in lot 2 were due to the addition of vitamin B_{12} concentrate. However, since this preparation undoubtedly contains impurities, it cannot be stated definitely that the growth-promoting activity of the concentrate was due to vitamin B_{12} *per se*, alhough the latter hypothesis seems likely.

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A Technique for Chronic Remote Nerve Stimulation[1]

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Chronic remote nerve stimulation is the usual terminology applied to a technique whereby a nerve in an intact animal is stimulated for periods of weeks or months by an electrical current, the ultimate source of which is removed from and not connected to the animal. By this method the effect of stimulation of a specific nerve in unanesthetized, intact animals can be assayed, thus eliminating disturbing emotional factors due to restraint. Chronic remote nerve stimulation permits close imitation of normal and certain abnormal physiological states.

Various methods for attaining remote stimulation have been tried in the past. Loucks (*12*), and Chaffee and Light (*2*) reported techniques in which a secondary coil was buried beneath the integument, leads from this being connected to electrodes on given nerves. A primary coil positioned over or around the buried unit induced a current in the secondary coil. High currents are required in the primary circuit to induce adequate currents in the secondary. This proves cumbersome and inefficient. These disadvantages can be partially offset by restraining the animal and closely approximating the two coils as Harris (*9*) is doing. However, since restraint of the animal must be employed, such techniques eliminate many of the desirable features of chronic remote excitation. Its great advantage over systems of chronic stimulation by means of lead wires brought out through the skin, as utilized by Hess (*10*), Cannon (*1*), Manning and Hall (*13*), Cressman and Blalock (*3*), Kottke, Kubicek, and Visscher (*11*), is that there is no possibility of infection traveling down the leads. This method also restricts the wave form of the stimulating voltage developed across the secondary coil.

Newman, Fender, and Saunders (*14*), and Greig and Ritchie (*8*) have reported success using radiofrequencies to provide an electromagnetic field for exciting the buried secondary coil. Fender utilized a frequency of 430-kc while Greig and Ritchie employed a 100-kc frequency. Along with other technical difficulties, polarization at the stimulating electrodes and broken lead wires due to intra-animal motion were the major factors in preventing the attainment of chronicity. Fender (*4–7*) did report one period of 5½ months of successful splanchnic stimulation but broken leads and polarization were always major handicaps in his experiments.

For the past year we have had in operation a system of remote stimulation utilizing radiofrequency for transmission of the signal to the receiver. Detailed studies of polarization with various wave forms have been made. Buried units have been devised and subjected to all the traumata possible in unanesthetized, unrestrained animals. Following is a description of the system which has met our minimal standards of chronicity and remoteness, i.e., stimulation over periods of 4 months in a cage 8 ft. in diam.

The receiver circuit consists of a flat pickup coil tuned to resonate at 1 megacycle by a condenser connected in parallel with it. The r-f voltage output from this is rectified by a germanium crystal and then applied to the nerve which is to undergo stimulation. A by-pass condenser is connected across the output terminals of the receiver to prevent r-f voltage from being applied to the nerve and to increase the receiver sensitivity.

An analysis of the receiver circuit shows that there are optimum values of the circuit elements for maximum sensitivity. The voltage output of the coil under optimum conditions is proportional to the 3/2 power of the coil diameter and to the 1/2 power of the radiofrequency. This would indicate that, within the limits of the experiment, optimal conditions may be obtained with a pickup coil as large in diameter as possible and of a high radiofrequency. The crystal rectifier should have as low a resistance as possible. The number of turns on the coil should be adjusted so that the product of its inductive reactance and Q is equal to the equivalent load resistance presented by the nerve and crystal rectifier. Sufficient capacitance should be added across the coil to produce resonance.

Two types of receivers were constructed: one was a flat disk with a single pickup coil and the other was a sphere with three coils mounted mutually at right angles. The flat receiver is used in experiments where the subject is held fixed for a time in such a position that the receiver coil is properly oriented with respect to the r-f magnetic field. The exciting field may be induced by a large primary coil which entirely surrounds the subject or by a small coil held in close proximity to the receiver. The spherical receiver is essentially three separate receivers with their output terminals connected in parallel. By mounting the pickup coils mutually at right angles the receiver will respond to an r-f magnetic field in any direction. With this receiver the subject may move around freely within a single primary coil 6–10 ft in diam and receive nearly uniform stimulation at all times.

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Flat single coil receivers which operate at a radiofrequency of 1 megacycle are made as follows: The coil is made by winding 17½ turns of number 26 AWG enameled copper wire on a form ¾ in. diam and 3/16 in. wide. The coil is painted with collodion to hold the turns together before removing from the form. Next a 2,500 mmfd resonating condenser, germanium crystal, and 3,000 mmfd by-pass condenser are mounted inside the coil. The electrode and ground leads are then attached to the circuit. The circuit is cast into a plastic disk of polyethylene. The ground plate is a tantalum or silver disk ¾ in. in diam and 0.02 in. thick with edges rounded and smooth.

The leads used in connecting the electrode and ground plate to the receiver are of the utmost importance. Flexible conducting leads have been made by overwinding a thread 0.015 in. in diam with two copper ribbons 0.0005 in. thick and 0.02 in. wide. The lead is insulated by covering with polyethylene tubing which has an 0.023-in. bore and an 0.014-in. wall thickness.

The electrode which wraps around the nerve is made from 0.002-in. silver foil ¼ × ¾ in. This is attached to the flexible lead by inserting the lead and a small wedge of silver foil into a small metal tube and then crushing the tube. The electrode is covered on the outside by 0.118 in.-diam polyethylene tubing ½ in. long which has been cut lengthwise so that the nerve can be inserted. The side of the tubing opposite the cut is pierced in the center to permit passage of the conducting lead and is fused to the end of the tube covering the lead. The other end of the tubing is fused to the polyethylene disk covering the receiver.

The three-coil spherical receiver is made in the same way as the single-coil receiver except that the coils are not cast in solid polyethylene but two hemispherical shells are placed around them and fused together. This makes a lightweight covering which is moisture proof.

There are many advantages to the use of radiofrequencies for transmitting the signal to the receiver and then applying the rectified output of the receiver to the nerve. Relatively low power equipment can be used. The stimulating voltage applied to the nerve can be made to have practically any wave form by proper modulation of the r-f transmitter.

In most experiments we have found it desirable to apply rectangular pulses to the nerve. This is accomplished by modulating the transmitter with a square wave generator in which the width, repetition rate, and amplitude of the stimulating pulses can be controlled over a wide range.

Electrode polarization may be made negligible by the use of rectangular pulses. The pulse width is kept very short (a few milliseconds), and the repetition rate is kept well below what appears to be the fatigue level of the neuromuscular junction. Rectangular pulses lend themselves to detailed analysis in determining optimum conditions for efficient and effective stimulation of specific nerves.

Our method has been used to stimulate radial nerves in the forelegs of unrestrained dogs. Functional electrodes have been maintained *in situ* for 11 months. Buried units have successfully stimulated the front paw via the radial nerve for over 8½ months. Stimulation of the splanchnics and the vagi in the lower thorax has been carried out for similar periods. Studies have been made of the reaction of the nerves to the electrodes. Grossly, there is no scar tissue response to the encompassing electrode, although microscopic sections of the nerves have shown moderate perineural fibroblastic proliferation.

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Recovery of the Virus of Eastern Equine Encephalomyelitis from Mosquitoes (*Mansonia perturbans*) Collected in Georgia

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Although mosquitoes have long been considered the probable vector for the virus of eastern equine encephalomyelitis (E.E.E.), so far there has been no published account of the recovery of this strain from mosquitoes taken in nature. However, the virus has been isolated from the chicken mite (*Dermanyssus gallinae*), and from chicken lice (*Eomenacanthus stramineus*) as recently reported by Howitt *et al.* (*4*). Merrill, Lacaillade, and TenBroeck (*5*) had demonstrated earlier that the eastern strain could be transmitted experimentally by several species of *Aedes* (*A. sollicitans*, *A. cantator*, and *A. taeniorhynchus*). They were unable to transmit the virus by *Culex pipiens* or *Anopheles quadrimaculatus*. Davis (*1*) found that five species of *Aedes* mosquitoes prevalent in Massachusetts, (*A. vexans*, *A. sollicitans*, *A. cantator*, *A. atropalpus*, and *A. triseriatus*) could transmit E.E.E. virus when tested in the laboratory, but no transmissions were obtained from other genera (*Culex*, *Mansonia*, or *Anopheles*). This note is to report on the recovery of the E.E.E. virus from the mosquito *Mansonia perturbans* Walker taken in nature.

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During the summer of 1948, a few horses in different parts of Georgia were diagnosed as having encephalomyelitis. The brains from two animals were sent to the U. S. Public Health Service Virus Laboratory in Montgomery, Alabama, where the virus of eastern equine encephalomyelitis was recovered from them. During the same period, mosquitoes were collected from different areas in the state by members of the Epidemiology Division of the U. S. Public Health Service in collaboration with the Georgia State Department of Health. Forty-three *Mansonia perturbans* were taken from farms in Burke and Jenkins Counties, where sick horses previously had been reported. These mosquitoes were put into glass ampules, which were sealed in a flame and then quickly frozen with dry ice and alcohol. They were sent in this frozen state to the laboratory in Montgomery. There they were pooled, washed with buffered saline, suspended in 3 ml of buffered saline containing 30% normal rabbit serum, and spun in the angle centrifuge for 20 min at 13,000 rpm. The supernatant fluid was removed and 0.03 ml was inoculated intracerebrally and 0.1 ml intra-abdominally into nine 12-day-old white Swiss mice. After 2–4 days, three animals died and four became sick and were killed. The brains were removed but, because of a bacterial contamination, the suspension of brain tissue was passed through a Seitz filter before inoculation of a second group of mice. The latter animals either died or showed typical convulsions in 2–3 days. Cultures of the brains were negative for bacteria, so that a third passage was made to mice. All of these animals either died or showed symptoms of an acute encephalitis. In a further passage the titer was 10^{-8} in mice.

This virus was then identified as that of the eastern equine encephalomyelitis strain, both by means of the neutralization test in mice and by cross immunity inoculations into immune guinea pigs. The virus was neutralized by the E.E.E. antiserum but not by that of the W.E.E. or St. Louis strains. Guinea pigs, previously proven immune to the stock E.E.E. strain by intracerebral inoculation of 70,000 lethal mouse doses of virus, withstood a dose of the new strain that was fatal for the control animals and for those immunized to the western equine virus. Moreover, an antigen prepared from a mouse brain suspension of this virus gave a positive complement-fixation against E.E.E. antiserum but not against those of the W.E.E. or St. Louis strains. The antigen titer was 3+ in a dilution of 1: 32 against the E.E.E. serum.

It should be stated here that the Venezuelan equine virus has been recovered by Gilyard (*2, 3*) from another species of the genus *Mansonia* (*Mansonia titillans*) taken in nature in Trinidad. Both *M. titillans* and *M. perturbans* are persistent feeders on warm-blooded animals, including horses and chickens. This makes these mosquitoes potentially dangerous vectors of equine encephalitis viruses if they are true vectors, rather than merely transient carriers. Further studies to establish the role of *M. perturbans* in the epidemiology of eastern equine encephalitis are planned for the coming season.

In summary, a filterable virus, proven to be antigenically and immunologically identical with that of the eastern equine encephalomyelitis virus, has been recovered from wild-caught specimens of *Mansonia perturbans* Walker. The infected pool of these mosquitoes was collected in Burke and Jenkins Counties, Georgia during the summer of 1948.

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A Convenient Microsyringe

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An accurate microsyringe is useful for dispensing minute quantities of fluids in laboratory experiments. This type of instrument was used for inoculating individual honeybee larvae in the honeycomb by adding spores of *Bacillus larvae* to the food in which the larvae float during the first two days of life (*1, 2*). Recently it has been improved to increase its accuracy and convenience, and has been used for feeding minute quantities of DDT suspended in 50% sugar syrup to individual adult worker bees. By this method as little as 1 μg or less of DDT can be fed to each bee. The unit of discharge is 1 μl.

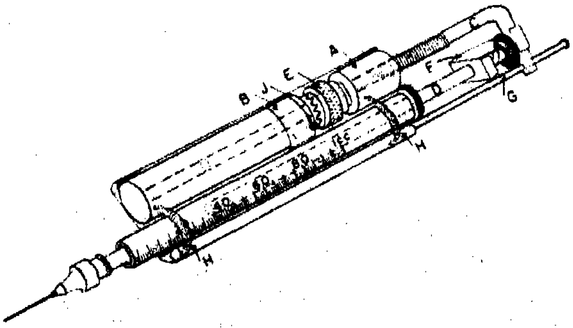

Fig. 1.

The complete instrument is diagramed in Fig. 1. The syringe is a 1-cc glass tuberculin type hypodermic syringe, the 1-cc calibration occupying a linear distance of 56.5 mm. The syringe holder is made of sheet brass formed to accommodate and hold the syringe in position. Two bushings, *A* and *B*, serve as bearings to guide the 3/16-in. feed screw *C*, which regulates the movement of the plunger *D* of the syringe. The screw is threaded 3/16-32. The feed device *E* is a knurled nut tapped to fit this screw, and on one end are cut notches or gear teeth. A hole is drilled in the bushing *B* under the teeth of the nut to accommodate a 5/64-in. steel ball *J* with a coil spring placed under it. The ball enters the space between the teeth as the nut is turned, resulting in a definite click.

The instrument is held in the right hand and operated by turning the nut with the thumb or forefinger. The syringe holder is cut away so that the nut may be reached from underneath. The clip *F* and a coil spring hold the plunger in position against the screw rod. The rod *G* is firmly attached to the syringe holder and serves as a guide for the screw rod *C* through which it passes.

Two light coil springs *H* attached to the central portion and hooked over two prongs soldered to the outside of the holder serve to hold the syringe firmly in place. The springs are unhooked for removal of the syringe.

With a feed nut of 14 teeth and a 32-thread screw there are 448 clicks per in. of screw, or 997 clicks to the 1 cc occupying a distance of 56.5 mm. This is equivalent to 0.0009965 cc per click or, for all practical purposes, 1 μl. By proper selection of the number of threads per in. in the screw, the number of teeth in the gear of the nut, and the diameter of the syringe, various sizes of drops may be obtained. The quantity of dissolved or suspended materials for a given dose may be calculated on this basis.

A fine long needle of 25 or 27 gauge, cut off bluntly, has been used for the small drops fed to bees. For accuracy it is essential that all air be removed from the syringe and that the temperature remain constant.

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The Caries-producing Capacity of Starch, Glucose, and Sucrose Diets in the Syrian Hamster

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The reports of experiments with the cotton and albino rat, in which various carbohydrates were incorporated in the diets to determine their relative cariogenic effectiveness, are either inconclusive or inconsistent (*2, 6, 7, 8*).

It has been shown that the Syrian hamster on a high carbohydrate diet will readily develop gross lesions of the teeth which are comparable to human dental caries (*1, 4*), and the use of this animal seems to have several advantages over that of the rat (*5*). An experiment was designed, therefore, in which the hamster was used for testing the caries-producing capacity of a monosaccharide, a disaccharide, and a polysaccharide.

Sixty-two hamsters (36 males and 26 females) were divided into three main groups with as nearly equal sex and littermate distribution as possible. At the initiation of the experiment, the ages of the animals ranged between 31 and 34 days. Beginning at this age, each of the three groups received diets which varied in composition only in the type of carbohydrate present. Group I received the following diet: raw cornstarch, 61%; whole powdered milk, 35%; powdered alfalfa, 3%; sodium chloride, 1%. In the diet of group II, the 61% cornstarch was replaced by an equal quantity of powdered α-glucose, and in the diet of group III, the starch was replaced by sucrose in the form of confectioner's sugar.

TABLE 1

CARIES SCORES ON CARBOHYDRATE DIETS

	No. of animals	Mean caries score	Standard deviation	Critical ratio	
				Starch	Sucrose
Starch diet					
Males	12	2	7	..	9
Females ...	9	0	0	..	11
Glucose diet					
Males	12	72	35	7	5
Females ...	8	44	27	4	7
Sucrose diet					
Males	12	163	57	9	..
Females ...	9	170	42	11	..

After an experimental period of 111 days, the animals were sacrificed, the teeth examined under a dissecting microscope, and the carious lesions charted and scored according to the method of Keyes (*3*). The mean caries scores are shown in Table 1. The difference in mean caries scores of the males on the various diets, and also the difference in the mean caries scores of the females on the various diets, are of a high order of statistical significance.

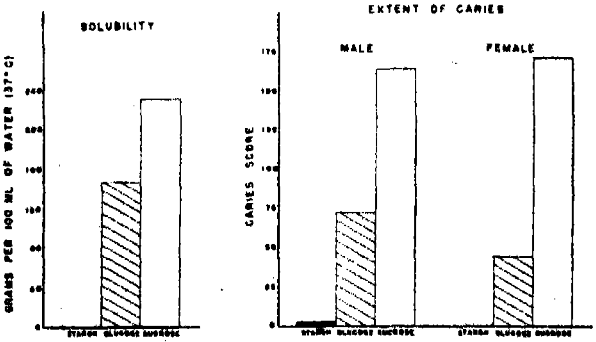

FIG. 1.

Thus it is seen that raw starch plays little if any significant role in the initiation of gross dental caries in the Syrian hamster. The feeding of a diet high in sucrose results in the highest caries scores, whereas a diet high in glucose results in caries scores intermediate between the starch and sucrose groups. Although the severity of dental caries in these three groups is roughly proportional to the solubility in water of the three carbohydrates (Fig. 1), it must not be inferred that solubility is the controlling factor in this experiment. No evidence is available except that cited above and no conclusions can be drawn at the present time. Further studies are now in progress using a larger number of carbohydrates of different solubility to determine whether such findings hold true in every instance.

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[1] National Institutes of Health senior research fellow.

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Synthesis of Amino Acids in the Rumen

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In 1891 Zuntz (*6*) presented the view that bacteria in the rumen of animals utilize nonprotein nitrogenous compounds to form protein, which in turn was used by the animals. In recent years it has been conclusively shown that protein is formed in the rumen from dietary urea and ammonium salts. The protein thus formed appears to be of relatively low biological value (*3–5*) but, to our knowledge, no attempt has been made to measure the amino acid composition of protein synthesized in the rumen.

In the course of studies designed to determine the amino acid requirements of farm animals, samples of diets, rumen material, and excreta obtained from three sheep and two goats fed a purified diet containing urea as the nitrogen source were analyzed for the ten essential amino acids. The animals were fed a diet containing corn sugar, 25%; cornstarch, 42%; cellophane, 20%; minerals, 5%; lard, 4%; and urea, 4%. Vitamins A and D were fed separately each day, but the B vitamins were not supplied because most of them have been shown to be synthesized in ruminants. After the animals had been on a constant amount of the diet for at least 20 days, collections of urine and feces were made for a 10-day period. Samples of rumen material were obtained by stomach tube at the end of the collection periods.

Lambs fed the urea-containing diet gained an average of 0.23 lb per day, as compared with 0.30 lb for similar lambs fed concurrently a ration containing casein. All animals were in positive nitrogen balance. As an average they stored 1.18 g of nitrogen each day. Biological values, calculated from the nitrogen balance data obtained from these animals and figures reported in the literature (*2*) for metabolic and endogenous nitrogen gave values of 56 for the diet containing urea and 82 for the casein ration.

The amino acids were determined in the purified diet, rumen material, and excreta by the microbiological technique after hydrolysis.

Hydrolysis was carried out in the autoclave in sealed tubes. Acid (10% HCl) was used for all amino acids except tryptophan. Alkali (5 N NaOH) was used for the latter. Organisms, obtained from the American Type Culture Collection, Georgetown University, Washington, D. C., were used for assay of the different amino acids as follows: *Streptococcus faecalis* #9790 for arginine, threonine, tryptophan, and valine; *Leuconostoc mesenteroides* P-60 #8042 for histidine, lysine, methionine, and phenylalanine; and *Lactobacillus arabinosus* 17–5 #8014 for isoleucine and leucine. The basal medium was the same as that reported in the literature for each organism, with the exception of slight modifications to be reported later (*1*).

In the analysis of rumen material, inhibition of growth of microorganisms was noted at the higher assay levels. This is being investigated further. The values for synthesis of amino acids in the rumen therefore are minimal.

TABLE 1

Amino Acid Contents of Rumen, Feces, and Urine Samples; and Daily Amino Acid Balance of Sheep and Goats Fed Urea Diet

Amino acid	Amino acid content (g/16 g N)				Apparent daily amino acid in g				
	Diet	Rumen material	Feces	Urine	Intake from		Losses in		Retention
					Diet	Rumen*	Feces	Urine	
Arginine	0.47	8.09	3.48	0.32	0.19	1.27	0.48	0.06	0.73
Histidine	0.13	1.44	1.27	0.12	0.05	0.59	0.18	0.02	0.39
Isoleucine	0.00	3.38	3.72	0.31	0.00	1.38	0.52	0.06	0.80
Leucine	0.36	4.96	4.35	0.43	0.15	2.04	0.61	0.08	1.35
Lysine	0.63	5.71	5.09	0.61	0.24	2.34	0.71	0.12	1.51
Methionine	0.08	1.62	1.48	0.09	0.03	0.66	0.21	0.02	0.48
Phenylalanine	0.13	2.47	3.39	0.22	0.05	1.01	0.48	0.04	0.49
Threonine	0.16	3.98	4.77	0.32	0.07	1.63	0.67	0.06	0.90
Tryptophan	0.04	0.61	0.94	0.04	0.01	0.25	0.18	0.01	0.11
Valine	0.34	3.82	4.89	0.38	0.14	1.57	0.69	0.08	0.80

* These values were calculated by multiplying the daily nitrogen intakes by the amino acid contents of the rumen material.

On the basis of the assays, the purified diet contained traces of all amino acids studied except isoleucine, even though urea was the only nitrogen source added. The presence of these amino acids in the purified diet appears to be a slight protein contamination from the cornstarch, sugar, and lard. The rumen material contained 9 to 20 times more of the amino acids that the diet fed (Table 1).

From a calculation of the amounts of amino acids furnished by the daily ration it would appear that the losses in feces and urine considerably exceeded the dietary intake. Obviously, this could not be the case because the animals were storing nitrogen and gaining weight. If the amino acid content of the rumen material is used to estimate the amounts available to the animals, a retention of the amino acids is indicated, which would explain the ability of the animals to grow. The fact that the animals have continued to gain in weight on the urea diet, containing no protein, for over 3 months is further evidence of the formation of amino acids.

Similar studies were carried out using a purified diet containing glycine as the only source of nitrogen. Rumen samples from sheep fed the glycine diet again indicated synthesis of the amino acids but at a lower level.

Results of these experiments show that the ten essential amino acids are synthesized in large amounts in ruminants fed urea as the only dietary source of nitrogen.

(*Supported in part by a grant from the Frasch Foundation.*)

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Experimental Amyloidosis in the Guinea Pig[1]

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In the course of a pathological study of chronic scurvy, we unexpectedly observed deposits of amyloid in various organs. So far as we know, this is the first report of experimental production of amyloidosis in guinea pigs.

Thirty young guinea pigs were fed scorbutogenic diets for varying lengths of time as shown in Table 1; 12 received the Sherman-La Mar diet as modified by Rinehart (*10*), and 18 the Crampton No. 5 diet (*3*). The control animals received 2.0 mg/day ascorbic acid, the acute scurvy group none, and the chronic scurvy group 0.2 mg/day. No amyloid was found either in the control or in the acute scurvy animals. Among the chronic scurvy guinea pigs, amyloid was demonstrated only in those animals which were sacrificed 8 weeks or longer after the beginning of the experiment. Six out of seven animals in this last group showed distinct amyloidosis. The lone exception was that of a guinea pig on the Crampton No. 5 diet, which was sacrificed at 19 weeks following a period of 4 weeks of unexplained clinical improvement.

TABLE 1

EFFECT OF DIET AND ASCORBIC ACID ON AMYLOID DEPOSITION IN GUINEA PIGS

Diet	Ascorbic acid supplement (mg/day)	Number of animals	Time sacrificed (weeks)	Pathological findings: Inanition	Scurvy	Amyloid
Rinehart	0	4	4–5	0	acute	0
	0.2	5	9–18	+	chronic	+ (In all 5)
	2.0	3	1–18	0	0	0
Crampton No. 5	0	7	4–5	0	acute	0
	0.2	2	8 and 14	+	chronic	+ (In both)
	0.2	5	1, 1, 2, 6, 19	+ (6–19 weeks)	+ (6–19 weeks)	0
	2.0	4	8–17	0	0	0

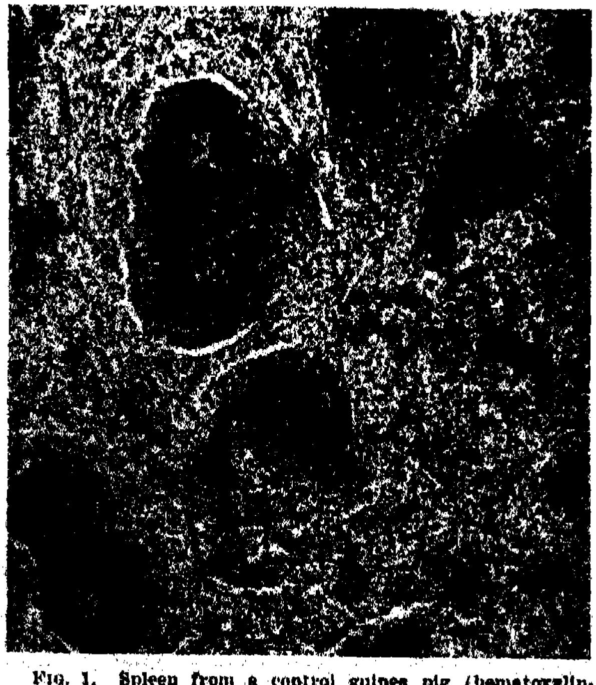

FIG. 1. Spleen from a control guinea pig (hematoxylin-eosin; ×65). Army Institute of Pathology.

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[1] The opinions expressed in this paper are those of the authors and do not necessarily represent the official views of any governmental agency.

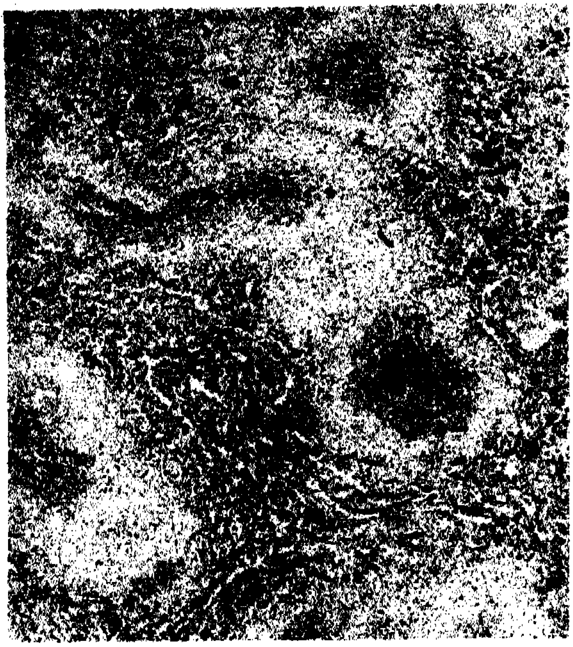

FIG. 2. Spleen from a guinea pig with chronic scurvy (hematoxylin-eosin; × 48). Army Institute of Pathology.

In animals showing amyloid deposition, the spleen was severely involved, the liver moderately, and the adrenal cortex only minimally in a few cases. Amyloid was not found in organs other than those mentioned in the chronically scorbutic guinea pigs.

Microscopically, the amyloid appeared in the spleen in the form of a thick band in the peripheral portion of the Malpighian corpuscles, extending at times to a minor degree into the pulp. (Figs. 1 and 2.) The central portion of the corpuscles appeared normal. The pulp was relatively poor in cells and contained prominent sinusoids. In the liver, amyloid was noted in moderate amounts between the hepatic cords and the walls of the sinusoids. The peripheral two-thirds of the hepatic lobules were as a rule more severely affected, the hepatic cells in these areas appearing small, atrophic, and compressed by the amyloid material. No definite intracellular amyloid was noted in the spleen or in the liver. In the adrenal cortex amyloid was noted in small amounts, again in close apposition with, and at times completely surrounding, the walls of capillaries lying among the cortical cells.

Iodine and sulfuric acid tests on the gross specimens, and crystal violet and Congo red stains on the sections, were all positive. However, the tinctorial response of the amyloid, particularly with Congo red, was not as brilliant as is usually seen in pathological specimens from man. The results of the tests with special stains, together with the typical distribution of the amyloid in the immediate neighborhood of capillaries and of reticulo-endothelial elements, is characteristic of this disease, in both man and experimental animal. The minor differences of the tinctorial response from that usually observed in man can probably be explained on the basis of age of deposition and molecular arrangement of the amyloid.

At the present time the exact chemical composition of amyloid is not known and the etiology and pathogenesis of amyloidosis are not clear. Experimentally, amyloidosis has been produced in mice, rats, hamsters, rabbits, dogs, and horses by various means (*1, 2, 4, 5, 7, 8, 9, 11, 13*). These include: supplementation of the diet with cheese; injection of bacteria, casein, sodium caseinate, pentose nucleotides, human serum, sulfur, selenium, or sodium silicate; inoculation with *Leishmania donovani;* and implantation of homologous tissues. Allegedly, amyloidosis has also been obtained in the experimental animal by injection of sodium bicarbonate, sodium hydroxide, hydrochloric acid, or animal tar (*12*). In addition, amyloid has been found in tumor-bearing mice (*6*).

Our observations do not warrant any positive conclusion, however attractive, as to the possible role of ascorbic acid or inanition, either alone or in combination in the pathogenesis of amyloid deposition. We feel, however, that these observations should be reported for two reasons: because to our knowledge, amyloidosis has never been detected in the guinea pig, and because amyloidosis has never been produced in animals by means of a deficient diet.

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Radiophosphorus and Radiostrontium in Mosquitoes. Preliminary Report

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The possibility of employing radioactive isotopes for marking mosquitoes for subsequent recognition has led to a study of behavior of P^{32} and Sr^{89} in colonized *Aëdes aegypti,* with a view to developing techniques by which such marking might be applied to large numbers of mosquitoes under field conditions. The usual methods of marking involve relatively drastic procedures, such as dusting and spraying the captive adult mosquitoes before

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[1] Supported jointly by the Medical Department of Nigeria, the Colonial Medical Research Service, and the International Health Division of The Rockefeller Foundation.

release, and thus subjecting them to considerable manipulation and trauma.

The ideal marking procedure should insure (1) ease of application to large mosquito populations; (2) minimal manipulation, preferably none at all; (3) ease of recognition of the marked mosquitoes without killing them, when this is desired; (4) certainty of persistence of the marking throughout the life of the mosquito; (5) freedom from deleterious biological influences.

It seemed that all of these conditions could probably be met by a radioactive element, provided it were bound by the mosquito tissues and not excreted. Sufficient radiation energy to be detected readily by the usual equipment would be essential, and the life of the radioactive isotope would need to be long enough to permit ready detection throughout the life of the insect.

Both P^{32} and Sr^{89} were found to be absorbed by the larvae and to be carried through the pupal stage into the adult. For marking purposes P^{32} was used as Na_3PO_4 and Sr^{89} as $SrCl_2$. It was found that concentrations giving radioactivities of 10–20 mμc per cc in the larval baths produced mosquito radioactivities of from 2 to 16 mμc, depending upon the concentration of the larvae and the conditions of feeding. A density of 5 larvae per cc gave satisfactory development provided adequate food was supplied.

Both isotopes showed similar behavior in that they were absorbed chiefly during the fourth stage and were not subsequently excreted from the adult body. The only significant loss was through egg laying, by which an appreciable fraction of P^{32} and a much smaller proportion of Sr^{89} would be passed out. There was no absorption by pupae.

There were no evidences of toxicity with a bath radioactivity of 0.2 μc per cc, which is about 100 times that needed for marking purposes. As the intensity of radioactivity was increased, the first indication of abnormality was the failure of mosquitoes to produce eggs. On dissection of such mosquitoes, no ovaries could be identified. This occurred especially with P^{32} at a radioactivity of about 200 mμc per mosquito. With still higher bath radioactivity, pupation did not occur.

Within the range of radioactivities used for marking purposes, there were no significant differences in longevity of the radioactive mosquitoes and their controls. With both isotopes, however, the females exhibited about twice the radioactivity of the males from the same baths.

Dissection experiments showed a similar distribution of the two isotopes in the mosquito body, a distribution which was independent of the total amount of radioactivity shown by the mosquito. Of especial interest was the finding that nearly 40% of the total radioactivity in female *Aëdes aegypti* mosquitoes could be found in the legs, while there was practically none in the wings.

Four field experiments were made involving the release of radioactive *A. aegypti* and their subsequent capture. In the two largest releases Sr^{89} was used; in the others P^{32} was employed. Photographic trays were used for the larval baths. It was found desirable to allow the larvae to develop to the third stage in other containers so that overcrowding did not occur until they were reaching the fourth stage, which was passed in the radioactive bath, where pupation and emergence also took place. For the first two experiments, pupae were counted into clean water and allowed to emerge from that container. Later, it was concluded that this method was too laborious and that it was possible to estimate the number emerging by dividing the amount of radioactive material disappearing from the bath by the average mosquito radioactivity.

The essential results of these field experiments are given in Table 1.

TABLE 1

SUMMARY OF FIELD EXPERIMENTS WITH RADIOACTIVE *Aëdes aegypti*

No.	Isotope used	Mosquitoes released, No.	Radioactivity bath μc/cc	Radioactive mosquitoes captured	Mean mosquito radioactivity mμc	Maximum age, days	Maximum distance, ft
I	P^{32}	5,000	0.023	15	15.8	9–13	450
II	P^{32}	9,221	0.085	27	2.4	8–13	850
III	Sr^{89}	10,000(?)	0.024	34	4.2	15–20	1,100
IV	Sr^{89}	252,000	0.019	240	1.8	28	3,800

Catches were made at a series of stations placed around the compass at varying distances from the release point. Human bait was used and the usual catching time was from 6 to 8 o'clock in the evening. Radial disposition of the stations was found most satisfactory for the first few catches of an experiment; later, irregular arrangements were used when it was desired to pay especial attention to certain areas.

It was found in field experiment IV that where the mosquito density in the bath is of the order of 5 per cc, rapid depletion of the radioactive material occurs, so that by measuring the radioactivities of mosquitoes emerging on successive days, it is possible to use the curves so obtained to determine the day of emergence and hence the age of mosquitoes caught subsequently. Also, where there is proper placing of the catching stations, the proportions of radioactive and nonradioactive mosquitoes of the species studied may be used with the estimate of the number emerging to give an approximation of the total population in the area.

It was found in these experiments that the mosquitoes were distributed largely by wind drift rather than their own flight, although the latter contributed. High winds and rains, however, tended to shorten the life span and thus limited the spread. Males and females traveled approximately the same distances, but the males had a survival time of only a few days.

Comments and Communications

On the Price of Books: A Publisher's Reply to Mr. Lowry

In your issue of the 22nd April, John R. Lowry protests against the present high prices of scientific books and suggests that books might be issued "in both unbound and bound form."

It has frequently been suggested that the publication of books in paper bindings would result in a considerable saving, but this is in fact not the case. The saving in most instances would amount to only a few cents, since the greater part of the binding cost is in the folding and collating of the sheets and the sewing of the signatures; this operation has to be performed by the binder whether the casing is paper or boards.

The *manufacturing cost* of many books has doubled in recent years, as your correspondent rightly points out. The list price charged by publishers has been increased by a much smaller proportion. I believe that books show a smaller increase in price over the prices of ten years ago than almost any other commodity on the market.

F. RONALD MANSBRIDGE

Cambridge University Press
American Branch

Precipitation Cycles

Recalling my own papers (Smithsonian Misc. Coll. Vol. 104, Nos. 3, 5, 1944; Vol. 111, No. 4, 1949) a letter from E. Fraselle, translated from the French, is of much interest:

> I have much pleasure in informing you that I am verifying the influence of the cycle of 27 days on the precipitation registered at Shangugu (Costermansville) in Ruanda (Afrique Orientale).
>
> The graph enclosed [Fig. 1] is computed from rainfall data of this station for 41 cycles from 4-1-1946 to 14-1-1949, as tabulated below. [The table is here omitted.]
>
> I fixed the zero of the first cycle at 4-1-1946, because it represents the phase of maximum rainfall for the cycle as indicated by the mean of the 41 cycles. This day would therefore correspond to the twelfth day of your cycle for Washington, Smithsonian Misc. Coll., Vol. 104, No. 3.
>
> In spite of the restricted number of cycles (41) used to establish my mean curve, the general correspondence of my results with yours is striking, and I cannot hide from you my satisfaction therein. This seems to me to have a great importance when one considers that Washington is situated in the Temperate Zone and Shangugu in the tropics.
>
> I am about to publish a paper on the subject in which I give the ratio of expected average rainfall on preferred days to that on all others as 1.60. This follows from the graph enclosed.

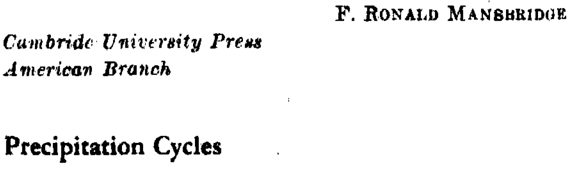

FIG. 1. The 27-day cycle in precipitation at Shangugu, lat. 2°30'S.: long. 28°54'E.; Alt. 1476 m. Ordinates, mean rainfall per day (mm) on cycle dates (abscissas) from 41 cycles. "Preferred" cycle dates +.

The matter was further referred to in my paper before the National Academy of Sciences (*Science*, 1949, 109, 436).

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Anode-Cathode Labeling in Electrochemistry

There has been much controversy over the use of the terms "anode" and "cathode" in the labeling of the electrodes in electrolytic and galvanic cells. From the standpoint of first year college students, as well as workers in the field, this has been an everlasting problem, always giving rise to doubt and uncertainty.

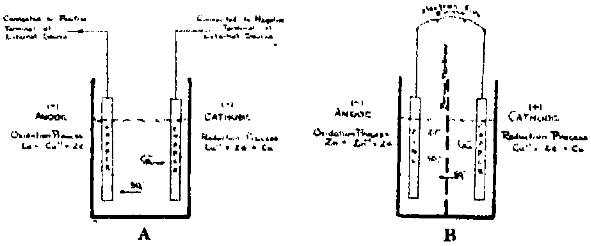

FIG. 1. A—Electrolytic cell. B—Galvanic cell (the Daniell cell).

The use of the terms with respect to an electrolytic cell, Fig. 1A, is not controversial, since it follows directly from Faraday's work on electrolysis. During electrolysis the electrode to which the anions migrate is termed the anode and that to which the cations migrate is termed the cathode. The electrode connected to the positive pole of the external circuit is the anode and that which is connected to the negative pole is the cathode.

On carrying over the use of these two terms to the galvanic cell, either one of two definitions must be followed: (1) the anode is always positive and the cathode always negative, or (2) the anions migrate to the anode and the cations migrate to the cathode. Both of these statements hold true for the electrolytic cell.

If the first statement is accepted, then in the case of the Daniell Cell (a galvanic cell), $Zn/ZnSO_4//CuSO_4/Cu$, the zinc electrode is the cathode and the copper electrode is the anode. This being the case, then the second statement cannot be true for the galvanic cell. From Fig. 1B, it can be seen that the copper ions migrate to the vicinity of the copper electrode and this we have termed anode according to statement 1. Confining ourselves strictly to Faraday's work and using these notations with respect to the galvanic cell, we would label the copper electrode as the cathode, for it is to this electrode that the cations, the copper ions, are migrating. No mention has yet been made of positive and negative electrodes. Actually, an electrode is negative only because it is more negative than the other electrode in the system.

Using the second definition, it is immediately apparent that the terms now indicate the chemical processes occurring in the vicinity of the electrodes—namely, oxidation in the vicinity of the anode and reduction in the vicinity of the cathode. It would seem better from the chemical point of view to label the electrodes with respect to the chemical processes occurring than by any other terms. Oxidation processes will always occur in the vicinity of the anode and reduction processes will always occur in the vicinity of the cathode if this definition is followed in the labeling of both electrolytic and galvanic cells. There can be no mistaking the processes of oxidation and reduction, since they can be defined in terms of electron loss and electron gain, respectively.

Affixing the terms positive and negative to the electrodes would be a very simple matter. In the electrolytic cell, that electrode to which electrons are being admitted is termed the negative electrode (cathode), for it is more negative than the other electrode in the cell. In the galvanic cell, that electrode at which electrons are being liberated is termed the negative electrode (anode), for it is more negative than the other electrode in the cell. The chemical processes occurring at the negative and positive electrodes in the electrolytic and galvanic cells will be different, but the processes occurring at the anode and the cathode will be the same. The diagram shown of the electrolytic and galvanic cells make clear the notation and charge of each electrode.

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Corrections

In the paper "Preliminary Observations on the Biological Effects of Radiation on the Life Cycle of *Trichinella spiralis*" by Alicata and Burr (*Science*, 1949, **109**, 595) the reports of earlier observations by E. E. Tyzzer and J. A. Honeij (*J. Parasitol.*, 1916, **3**, 43), B. Schwartz (*J. Agric. Res.*, 1921, **20**, 845), and others, on the deleterious effects of radiation on the reproductive tissue of *T. spiralis* were inadvertently omitted from the list of references.

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A typographical error in Table 1 of my paper "The Validity of the Use of Tracers to Follow Chemical Reactions" (*Science*, 1949, **110**, 14), under the entries for chlorine makes the estimated maximum ratios for the tracers Cl^{36} and Cl^{38} somewhat ambiguous. The stable isotopes should be written as Cl (natural abundance). The ratios were calculated for reactions with the tracers Cl^{36} and Cl^{38} in systems containing chlorine of natural isotopic abundance. Due attention has been given to the fact that the Cl^{35} and Cl^{37} will react at different rates.

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Book Reviews

Kinematic relativity: a sequel to relativity, gravitation and world structure. E. A. Milne. New York: Oxford Univ. Press; Oxford, Engl.: Clarendon Press, 1948. Pp. vi + 238. $6.50.

This book is a presentation of the author's theory of cosmology and physics. It is a sequel to his study *Relativity, gravitation and world structure* (1935), but can well be read independently from the earlier volume. It is a fascinating treatise, centered around a brilliant idea, excellently presented and showing unusual skill in the elaboration of some of the details. Even though the reviewer could not agree with all parts of the book, his admiration never slackened for the scope of the work and the wealth of results obtained by the author with the help of only a handful of collaborators.

The central idea of Milne's theory is a restatement of Mach's principle (cf. p. 3) that the laws of nature are a consequence of the contents of the universe. Our expanding universe is, however, an ordered structure, consisting of galaxies moving as if they had originated at a certain time at a common point (the "origin of the world") and moved away from each other henceforth. There is, therefore, it can be claimed, no purpose in establishing laws of motion which would be valid in an arbitrary type of universe or in setting up laws of invariance which disregard the structure of our universe. In our universe, a definition of absolute rest, at every point of space time, can be obtained by considering the motion of the galaxies at that point. The coordinate systems in which matter, on the average, is at rest along the time axis are, according to Milne, preferred over other coordinate systems, but are mutually equivalent. The equivalent coordinate systems form a sixparametric manifold: three parameters are necessary to give the "average material point" whose world line coincides with the time axis of the coordinate system, and three parameters give the orientation of the space axes. The equivalent coordinate systems thus form a much smaller manifold than in Einstein's special theory of relativity, in which ten parameters are necessary to describe an inertial coordinate system. In Milne's theory, coordinate systems which have a common origin ($x = y = z = t = 0$), but are in motion with respect to each other, are not equivalent any more unless the common origin is the origin of the world. If this is not the case, the coordinate system which is at rest with respect to the average motion of matter at its origin is preferred. Mathematically, the group of Milne's equivalent coordinate systems is the homogenous Lorentz group (with the origins at the origin of the world); for Einstein's equivalent coordinate systems it is the inhomogeneous Lorentz group. This restriction of the equivalent coordinate systems to a smaller manifold than in Einstein's special theory is the basic postulate of Milne's theory.

The derivation of the transformation between Milne's preferred coordinate systems (i.e., the derivation of the Lorentz transformation) is carried out in part I of the book, without making use of the usual devices of rigid rods and perfect clocks, by a brilliant piece of reasoning. The assumption is introduced that it is possible to regraduate the time scales of all preferred coordinate systems in such a way that if the light signal from A's clock at time t reaches B's clock at time t' (by B's clock) then the signal from B's clock at time t also reaches A at time t' (by A's clock). A set of clocks satisfying the above condition and each moving with the average motion of matter at its position is called an equivalence. The existence of equivalences essentially makes space "flat" in the sense of Reimann-Einstein—an assumption which has been criticized a great deal, but which is certainly at least a permissible assumption.

The postulate of the existence of equivalences does not fix the time scales of all observers uniquely. On the contrary, it is shown that one of the observers can renormalize his clock by introducing a new time measure $T = f(t)$, if the other observers do likewise. Milne considers in particular two time measures: the t-measure corresponds most closely to the time scale of conventional physics and has been used in the above qualitative discussion, while the τ scale is obtained by setting $\tau = t_0 ln t/t_0$ with an arbitrary t_0. In t-measure the transformation between coordinate systems is by Lorentz's formulae, with the origin of the world corresponding to $t = 0$. In τ-measure the origin of the world was at $\tau = -\infty$ and it is shown that actually the τ-measure coordinate systems can be considered to be at rest with respect to each other.

Milne's use of equivalences instead of rigid measuring instruments for the definition of his coordinate systems, as well as his emphasis on an elastic time scale, are, in the opinion of this reviewer, distinct advances in the epistemological sense. However, a study of his arguments fails to support the author's claim (p. 32) that he has not used the results of the experiments which conventionally go into the establishment of Lorentz's formulae. Similarly, the reviewer found it disturbing that the possibility of the renormalization of the clocks of all observers so that the equivalence axiom is satisfied for any pair of them has not been introduced more explicitly as an assumption.

This discussion of part I of Milne's book may indicate the stimulating and thought-provoking character of all four parts. Part II deals with the dynamics of a free particle. In the conventional special theory of relativity, Newton's first law is an immediate consequence of the equivalence of all coordinate systems which are in uniform motion with respect to each other. This is not the case in the present theory and the analogue of Newton's first law actually does not follow from the axioms introduced in part I. The most important result of part II is that Newton's first law in its original form is valid only in the coordinate systems which use τ-measure. The author attempts to give a derivation of this result, but his proof appears to be not much more than a plausibility argument. The apparent accelerations in t-measure are interpreted as the gravitational effect of the substratum, by assuming that the gravitational constant increases linearly with t.

The most interesting section of part II deals with the dynamics of light. The observed magnitude of the red shift of receding nebulae, which causes difficulties with the conventional theory, appears as a natural consequence of the author's concepts. The reviewer would have liked to see at this point a discussion of the basic experiments which have led to the special theory of relativity, such as the Michelson-Morley and the Trouton-Noble experiments, on the basis of the theory here presented. It would have been particularly important to discuss these experiments from the point of view of an observer who is in motion with respect to Milne's preferred coordinate systems, i.e. an observer who uses a coordinate system which is a preferred one in Einstein's theory of relativity but not in Milne's. The reviewer must also admit that he completely failed to understand section 133, dealing with the frequency of atomic transitions. It seems to him to follow from the argument presented on page 120 that light emitted by one galaxy and reflected back by a distant one cannot be absorbed at all by the original galaxy; as a result of the two kinds of Planck's constants, atoms which have the right resonant frequency do not possess the proper energy differences between their stationary states and conversely. This certainly could not have been the author's meaning.

The most interesting sections of part III deal with the structure of spiral nebulae. Again, the claim can be made that Milne's theory accounts better for the observations than does the conventional picture. Finally, in part IV, dealing with electrodynamics, the author ventures rather far into the field of speculation.

This summary should suffice to give an idea of the scope and significance of Milne's book. It is a book of many ingenious ideas, the concept of the change of the fundamental constants with time being only *one* of the author's original contributions. The reviewer suspects that most readers will disagree with some details of the book, just as he did. He hopes, however, that they also will find it highly interesting and stimulating, if somewhat too mathematical reading.

E. P. WIGNER

Princeton University

NEWS and Notes

M. F. Ashley Montagu has resigned as associate professor of anatomy at Hahnemann Medical College, Philadelphia, to become chairman of the newly created Department of Anthropology at Rutgers University, New Brunswick, New Jersey, effective July 1.

James F. Bonner, professor of biology at the California Institute of Technology, has been elected president of the American Society of Plant Physiologists. He succeeds **Donald B. Anderson**, North Carolina State College.

Theodore L. Althausen, professor of medicine at the University of California Medical School, will spend six months at the Walter and Eliza Hall Institute for Medical Research at the Royal Melbourne Hospital in Australia. Dr. Althausen will conduct research in diseases of the liver and disturbances of intestinal absorption.

William Walter Greulich, professor of anatomy at Stanford University, has been appointed executive head of the Department of Anatomy to succeed **Charles Haskell Danforth**, who is retiring at the expiration of the academic year.

Hans Ris, associate in physiology at the Rockefeller Institute, has been appointed a professor in the Department of Zoology at the University of Wisconsin.

Douglas M. Whitaker, dean of graduate study at Stanford University, will attend, under the auspices of the Rockefeller Foundation and the U. S. Military Government, a series of conferences in Germany on German universities. Dr. Whitaker will serve as consultant on teaching and research in the biological sciences.

Lee E. Farr, director of research and physician-in-chief of the Alfred I. du Pont Institute of the Nemours Foundation in Wilmington, Delaware, has been appointed head of the Medical Department at Brookhaven National Laboratory.

Visitors

Recent visitors at the National Bureau of Standards included: **Lars Gunnar Sillen**, research associate, University of Stockholm, Sweden; **Douglas R. Hartree**, research associate, The Cavendish Laboratories, Cambridge, England; **T. H. Morton**, of Cortaulds Limited, England; **Herman Bertling Hederra**, professor of applied seismology, University of Chile, Santiago; **Tong H. Ahn**, director, National Central Research Laboratory, Korea.

Julio Enrique Toral, pediatrician at the School of Medicine of the University of Cuenca, Ecuador, after a brief visit to Washington, D. C., will make a tour of medical schools and centers throughout the country to confer with colleagues in his field.

Yngve Ohman, of the Stockholm Observatory at Saltsjobaden, Sweden, holds a research associate appointment at the High Altitude Observatory of Harvard University and the University of Colorado at Boulder. Dr. Ohman will continue his research at the observatory until October.

Grants and Awards

The 1949 Gold Medal of the American Society for Metals will be presented to Edgar C. Bain, vice president of Carnegie-Illinois Steel Company, on October 20, during the 31st National Metal Congress and Exposition.

The $1,000 Eli Lilly Award in Biological Chemistry has been granted to Irving M. Klotz, associate professor of chemistry at Northwestern University. Dr. Klotz is being honored for his research on proteins. The award will be presented on September 19, at the Atlantic City meeting of the American Chemical Society.

The Geological Society of South Africa has extended an invitation of membership to George B. Barbour, dean of the College of Liberal Arts at the University of Cincinnati. The society is honoring Dr. Barbour for his research in South Africa on prehistoric man.

The 1949 Award of Merit of the American Hospital Association was granted to Claude W. Munger, former director of St. Luke's Hospital in New York. Dr. Munger is a former president of both the association and the American College of Hospital Administrators.

The Francis J. Clamer Medal of the Franklin Institute of Pennsylvania has been awarded to William Hume-Rothery, lecturer in *metallurgical chemistry at Oxford, in* recognition of his work in determining and interpreting the structure and behavior of metallic equilibrium systems.

Fellowships

Five $1,500 predoctoral fellowships for the study of the applications and implications of atomic energy are available at the University of Michigan for 1949–50. Applications will be accepted through *August 15* and appointments will be made by September 1. Appropriate research for the fellowships should fall into one of the following divisions: the use of radioactive isotopes in biological, physical, and engineering sciences; the physical, mathematical, or chemical aspects of nuclear theory; the social, philosophical, legal, or economic aspects of nuclear energy; and educational needs of this field. Inquiries may be addressed to Dean Ralph A. Sawyer, Horace H. Rackham School of Graduate Studies, University of Michigan, Ann Arbor, Michigan.

The Department of Biology of Emory University, Georgia, has inaugurated a graduate program in biology involving advanced studies and research leading to the Ph.D. degree. The program represents an enlargement of the graduate program of studies leading to the M.A. degree, which has been offered in biology at the university for 30 years. Special emphasis will be placed on cellular biology. Two nine-month fellowships for Ph.D. candidates are available, one of $1,200 and another of $1,000. Several fellowships and assistantships with stipends of $900 are available at the M.A. level.

The National Research Council's Committee on Growth, acting for the American Cancer Society, is accepting applications for grants and fellowships. Applications for new grants in cancer research are acceptable until *October 1.* Investigators now receiving grants will be notified regarding applications for extension. Final decisions on applications will be made in most cases soon after February 1, 1950, and grants approved at that time will become effective July 1. Fellowship applications may be submitted at any time. Those received prior to November 1 will be acted upon by the committee in December, those received between November 1 and March, in April. Fellowships will begin July 1, 1950, unless otherwise indicated by the applicant. Communications should be addressed to the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Colleges and Universities

Columbia, Harvard, Princeton, and Yale Universities will receive $150,000 each for scientific education and research during the academic year 1949–50 under the first distribution of the $34,000,000 Eugene Higgins Scientific Trust.

At Columbia, the largest single allocation of the initial grant will be used for work on nuclear, atomic, and molecular physics in the Pupin Laboratories, and at the new cyclotron plant at Nevis. The Harvard program will include expansion of basic research projects in medicine and dental medicine. Princeton's Departments of Science and Engineering will use the funds for support and expansion of research projects in physical and analytical chemistry, and chemical and electrical engineering. The Yale grant will be applied to fields of medical research, including a major project in microbiology.

The Higgins Scientific Trust was established by the late Eugene Higgins, son of a pioneer textile manufacturer. Benjamin Strong, president of the United States Trust Company of New York, is chairman of the board of control, which is composed of the presidents of the four beneficiary universities.

Ohio State University has received a gift of $9,000 from the Edward Orton, Jr. Ceramic Foundation for research in ceramic engineering. The study will be conducted by H. G. Wolfram, former vice president of Pemco Corporation, Baltimore, Maryland, manufacturers of porcelain enamels, who will join the university's Department of Ceramic Engineering as research associate.

Meetings and Elections

The American Institute of Chemical Engineers will hold a regional conference in Montreal, Canada, September 6–9. The program will include discussion of Canadian natural resources, the economic significance of Newfoundland, the development of water power, and the aluminum industry. Papers on oil technology and metallurgy will also be presented. A complete program can be obtained from the American Institute of Chemical Engineers, 120 East 41st Street, New York City 17.

Thermodynamics in physical metallurgy will be the subject of a two-day symposium, sponsored by the American Society for Metals, to be held October 15–16 in Cleveland's Public Auditorium preceding the opening of the 31st annual National Metal Congress and Exposition, October 17–21. Clarence Zener, professor of physics, Institute for the Study of Metals, University of Chicago, is chairman of the symposium series and will speak on the "Contributions of Statistical Mechanics" during the morning session, October 15. Among the other participating scientists are P. W. Bridgman, Hollis Professor of Mathematics, Harvard University; A. W. Lawson, associate professor of physics, Institute for the Study of Metals, University of Chicago; John Chipman, professor and head of the Department of Metallurgy, Massachusetts Institute of Technology; and Frederick Seitz, professor and head of the Department of physics, Carnegie Institute of Technology.

A symposium on small angle X-ray scattering will be held at the University of Missouri in Columbia, on October 21 and 22. Contributed papers will be welcomed. The tentative schedule thus far includes papers by R. D. Dragsdorf, A. Heyn, P. J. Kaesberg, P. C. Sharrah, G. Vineyard, and K. L. Yudowitch. On October 21, P. Debye, of Cornell University, will give an O. M. Stewart Lecture on "The Interpretation of Scattering Experiments in Terms of Structure," in which he will include references to recent work on light scattering. Those who are interested in attending the symposium or in presenting a contributed paper should write to Prof. George H. Vineyard, Department of Physics, University of Missouri, Columbia.

The 96th convention of the Electrochemical Society will be held at the La Salle Hotel, Chicago, October 12–15. Symposia on electrodeposition, corrosion, and organic electrochemistry, and special round table sessions on batteries and organic electrochemistry are being scheduled. Additional information may be obtained by writing to Henry B. Linford, Secretary of the Electrochemical Society, 235 West 102nd Street, New York 25.

The annual meeting of the **American Society for the Study of Arteriosclerosis** will be held November 5–7 at Hotel Knickerbocker, Chicago. Information may be obtained from Cowles E. Andrus, Program Chairman, 24 East Eager Street, Baltimore, Maryland.

The Annual Conference of Midwestern Parasitologists elected the following officers for 1949–50 at its first conference, held at the University of Wisconsin June 20–21: presiding officer, R. V. Bangham, Wooster College; secretary-treasurer, R. J. Porter, University of Michigan.

Autocorrelation. Because of the extensive interest in uses of autocorrelation analysis for scientific problems, the Woods Hole Oceanographic Institution organized a symposium for the Office of Naval Research on June 13 and 14. The purpose of the conference was to present and interpret results of applications of the relatively new and powerful method of autocorrelation analysis of finite amounts of data. Since the applied mathematician has the job of solving the problem as it comes to him from nature, he must generally modify the mathematical methods he proposes to use in such a fashion as to fit the data. For instance, in the case of time records of natural phenomena, the resulting time series is not stationary, its mean is usually not zero, and the series is seldom long enough to be considered infinite. Consequently, experimentation with theoretical mathematical procedures is essential if the resulting representation is to possess physical significance. It is, for instance, the application of certain mathematical procedures to time series analysis, where the theoretical conditions are not fulfilled, that has resulted in claims of a bewildering variety of periods or cycles which cannot be substantiated.

The underlying concept of autocorrelation analysis is that the behavior of a physical phenomenon, and of the dynamics causing it, is directly associated with the problem of predicting the future course of a time series from its past behavior. Also, the distance into the future which the phenomenon may be accurately forecasted gives an indication of the amount of dynamics associated with the phenomenon itself. This procedure is to be distinguished from one in which a mathematical theory is set up, as, for instance, that obtained by application of periodogram or Fourier series analysis to time series, but which will have a physical significance only if it can be extrapolated into the future.

Autocorrelation analysis is employed both as a prediction mechanism and as a means of generalized harmonic analysis. The correlogram and the Fourier transform of the autocorrelation functions into power spectra serve to describe finite amounts of basic data by measuring the physical properties of period, amplitude and damping coefficients. It can be shown that the autocorrelation function may be obtained from the spectrum of the series, and the spectrum may also be obtained from the autocorrelation function.

Edwin B. Wilson acted as chairman during the two-day session at Woods Hole. Papers were given by Edwin B. Wilson, Y. W. Lee, David Middleton, G. P. Floyd, John W. Tukey, Philip Rudnick, A. T. McNish, George P. Wadsworth, Carl Eckart, and H. R. Seiwell. The proceedings were recorded and are in process of editing for publication.

H. R. SEIWELL

Committee of the National Academy of Sciences on the Investigation of Cortisone. The recent publication by Hench, Kendall, Slocumb, and Polley of the dramatic effectiveness of the adrenal cortical steroid, Cortisone (first isolated by E. C. Kendall), in the treatment of rheumatoid arthritis has posed an important problem of distributing the very limited amount of that substance which will be obtainable during the remainder of this year. Originally obtained from the cortex of the adrenal gland, it is now being prepared synthetically from a bile acid. While the value of Cortisone in controlling the symptoms of rheumatoid arthritis is regarded as established, much remains to be learned concerning its possible untoward effects, its usefulness in other diseases, and the mechanism of its action. It has been decided, therefore, that the small amount which can be made during the last five months of 1949 shall be used only for clinical and experimental research. It will be made available to those investigators who are in the best position to provide the information vitally needed to insure its safe and effective use.

The Research Corporation, a nonprofit organization which administers patents in the interest of public welfare and for the furtherance of scientific research, has aided in the development of the synthetic processes for making Cortisone. The corporation will continue to further the development of these processes and to stimulate research on the mechanisms of action of the compound. In fulfilling these functions, the Research Corporation has requested the president of the National Academy of Sciences to appoint a Committee on Investigation of Cortisone, with assurance that its recommendations will be accepted as final with respect to all of the available 1949 supply.

The membership of the committee, appointed with the sanction of the Council of the Academy, is as follows: Chester S. Keefer, chairman; Hans T. Clarke, E. A. Doisy, Robert F. Loeb, C. N. H. Long, E. K. Marshall, Jr., Joseph T. Wearn. David E. Price has been appointed by the Acting Surgeon General to act as liaison between the committee and the U. S. Public Health Service.

The committee is planning arrangements designed to utilize to the fullest possible extent the resources of the National Research Council and the information and advice of experienced and competent investigators in the United States and Canada. Not only will the fields of rheumatism and other diseases for which relief may be anticipated continue to be investigated, but also fields of physiology and pharmacology which are basic to fuller understanding and further advance.

While the Academy has no funds with which to buy Cortisone or to support investigations, it is confidently expected that the needed funds will become available from both public and private sources.

The Academy committee has accepted this responsibility because of the deep conviction that a new discovery of the greatest importance to the health and welfare of countless people has been made and that it is vital to promote its most rapid and intelligent development.

Applications for a supply of Cortisone must be submitted on a form that can be obtained from the chairman of the committee, Dr. Chester S. Keefer, 2101 Constitution Avenue, Washington 25, D. C. It must be emphasized that consideration will be given only to requests from institutions where adequate facilities for investigation and clinical control are available.

The Atomic Energy Commission has announced that cyclotron-produced radioisotopes are to be made available to U. S. researchers, to augment the present distribution of isotopes produced by the Oak Ridge pile. Although the pile far surpasses the cyclotron in quantity production, the cyclotron produces a wider variety of isotopes. Because no one laboratory can satisfy the demand without seriously interfering with its research program, arrangements for irradiation will be made with a number of institutions.

The initial group will include the Massachusetts Institute of Technology, the University of Pittsburgh, Washington University at St. Louis, and the Crocker Radiation Laboratory at the University of California. The Department of Terrestrial Magnetism of the Carnegie Institution will participate in the general program.

Processing of irradiated targets will be carried out by the Oak Ridge National Laboratory, in facilities already provided for handling reactor-produced isotopes, and the commission's Isotopes Division will handle allocation. Cyclotron-produced isotopes are relatively costly and the commission will subsidize the program to some extent. All isotopes are made available free of production charges for cancer research.

At first only isotopes having half-lives of more than thirty days will be distributed. Included in this group are: 43-day beryllium 7, 3-year sodium 22, 44-day iron 59, 4-year iron 55, 250-day zinc 65, 90-day arsenic 68, and 56-day iodine 125. Others will be added later.

Distribution under the new program will be limited to the U. S. because cyclotrons are in operation in many other countries and the isotopes they produce are more readily available abroad than pile-produced isotopes.

Judges in the **Third Annual International Photography-in-Science Salon** were announced today by *The Scientific Monthly*, which, in cooperation with the Smithsonian Institution, sponsors this annual contest. Merle A. Tuve, of the Carnegie Institution, will be the judge for the physical sciences; Ronald Bamford, of the Department of Botany, University of Maryland, for the biological sciences; A. A. Teeter, recently of Charles Pfizer & Company, New York City, for chemistry; Emanuel Krimsky, of Polyclinic Hospital, New York City, for the medical sciences; and Alexander J. Wedderburn, of the Graphic Arts Division, Smithsonian Institution, for photography.

Entries in the competition, which was established to encourage and extend the use of photography as a basic research tool, will be received by the Editor of *The Scientific Monthly*, 1515 Massachusetts Avenue, N.W., Washington, D. C., from August 24 to September 14, 1949.

First, second, and third awards and five honorable mentions will be given in each of two divisions, black-and-white and color. The Judging Committee will consider the initiative, originality, and results obtained more than the composition and pictorial quality. All photographs must be taken for scientific purposes.

The prints selected for awards and display will be shown at the U. S. National Museum during October 1949, and at the New York Meeting of the AAAS, December 26–31, 1949. They will then go on a tour of important scientific institutions in this country and abroad.

A contribution to the CARE book program to replace scientific, professional, and technical books lost during the war years in Europe and Asia (see *Science*, July 22, p. 106) has been proposed in bills S. 1998 and H. R. 5186, recently referred to the Senate Armed Services Committee and the House Foreign Affairs Committee. The contribution is to be in an amount equal to a fund which was created during the war out of wages earned by conscientious objectors, working on farms and in hospitals. The wages were paid to the Treasury, where they were kept in a special deposit until the end of the war. On March 7, 1947, the fund, totaling $1,245,018, was listed as miscellaneous receipts by the Treasury and technically, therefore, no longer existed as a separate fund. The Comptroller General ruled that the payments belonged to the United States but, since they were not collected from taxes, the Treasury Department indicated no objection to the appropriation of the fund for relief purposes, which is the preference expressed in an informal poll among the men whose earnings created the fund. In 1949 the National Service Board for Religious Objectors, after examination of the CARE Book Program, requested the use of this fund for replacement of war-destroyed books, as provided in the proposed legislation.

Recently Received—

Clinical Problems of Advancing Years. (Symposium presented by Smith, Kline & French Laboratories.) Smith, Kline & French, Philadelphia 1, Pa.

Our Dwindling Resources (articles relating to scientific conservation of America's resources as reprinted from *Monsanto Magazine*). Monsanto Chemical Company, St. Louis 4, Mo.

Hybrid Corn (Maize) in Theory and Practice by Gordon Haskell. John Innes Horticulture Institution, Merton Park, London, S.W.19, England. $1.00.

Make Plans for—

Meteoritical Society, 12th annual meeting, September 6–7, University of Southern California, Los Angeles.

American Psychological Association, September 6–10, Shirley Savoy Hotel, Denver, Colorado.

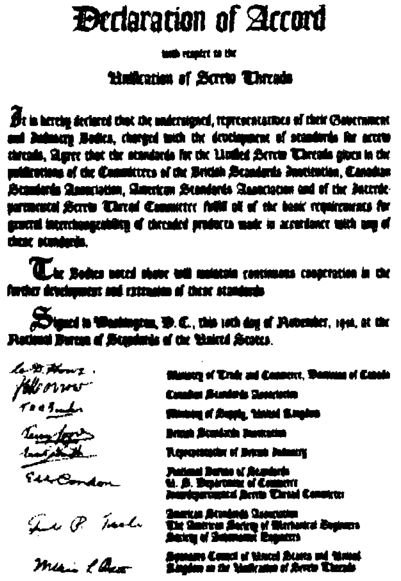
Biological Photographic Association, 19th annual meeting, September 7–10, Hotel Cleveland, Cleveland, Ohio.

New Screw Thread Standards

E. G. Wertheimer

Sterling Bolt Company, Chicago

On November 18, 1948, a group of distinguished gentlemen representing governmental bureaus, engineering and standards associations, and industries of Great Britain, Canada, and the United States signed an important document. That document was the Declaration of Accord with respect to the Unification of Screw Threads and is reproduced here (Fig. 1).



Declaration of Accord

with respect to the

Unification of Screw Threads

It is hereby declared that the undersigned, representatives of their Government and Industry Bodies, charged with the development of standards for screw threads, Agree that the standards for the Unified Screw Threads given in the publications of the Committees of the British Standards Institution, Canadian Standards Association, American Standards Association and of the Interdepartmental Screw Thread Committee fulfil all of the basic requirements for general interchangeability of threaded products made in accordance with any of these standards.

The Bodies noted above will maintain continuous cooperation in the further development and extension of these standards

Signed in Washington, D. C., this 18th day of November, 1948, at the National Bureau of Standards of the United States.

Ministry of Trade and Commerce, Dominion of Canada

Canadian Standards Association

Ministry of Supply, United Kingdom

British Standards Institution

Representative of British Industry

National Bureau of Standards
U. S. Department of Commerce
Interdepartmental Screw Thread Committee

American Standards Association
The American Society of Mechanical Engineers
Society of Automotive Engineers

Sponsors Council of United States and United Kingdom on the Unification of Screw Threads

Fig. 1.

Announcement of the signing was made in a few daily newspapers and national magazines. Since then the public seems to have forgotten it, screws and screw threads apparently being so prosaic as to invite only passing interest. There was nothing about the event to make it as dramatic as nuclear fission, atomic energy, a test for detecting the presence of cancer, or jet propulsion, and yet its effects are momentous.

Screw threads are essential to the mechanisms and structures of our modern technologic society. One has only to think how many objects in his immediate surroundings are held together by bolts, nuts, and screws to realize the great number of industries that are involved. Almost all assembly line and durable goods industries are affected by the new standards.

The first attempt at a standard thread form was made about a hundred years ago by a British toolmaker named Joseph Whitworth. British industry adopted this standard in 1841 or about then and it became known as the British Whitworth Thread. It is distinguished from the thread we have used in this country by its 55° thread angle and its rounded crest and root as shown in the contour sketch, Fig. 2.

In 1864 a Philadelphian by the name of William Sellers urged the Franklin Institute of that city to establish and adopt a different design of thread. A number of contentions were advanced to demonstrate why the Sellers thread was a better one for our industry. It was subsequently adopted as the standard for the United States and has been known recently as the American National Thread. It is principally distinguished from the British Whitworth Thread by its 60° thread angle and its flat crest and root as shown in contour in Fig. 3.

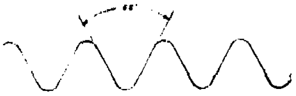


Fig. 2. Contour of British Whitworth Thread.

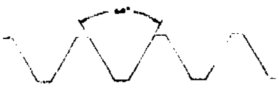


Fig. 3. Contour of American National Thread.

It is not necessary to discuss many of the scientific and engineering factors which reacted against each other when an attempt was made to interchange products made in accordance with the two systems. The interference is self-evident in a comparison of Figs. 2 and 3. It is this lack of interchangeability that caused so many difficulties over the years, not only here but in Britain and Canada as well. Canada suffered doubly because its trade and commerce were of such a nature as to require some products to be adaptable to either one of the standards.

It is natural for a group of people to consider its own particular product, principal, or standard to be the best. For years Britain insisted upon requiring the use of a 55° thread and the United States was just as insistent upon a 60° thread. The loss in trade between the two countries, where threads or threaded fasteners were important, has never been measured.

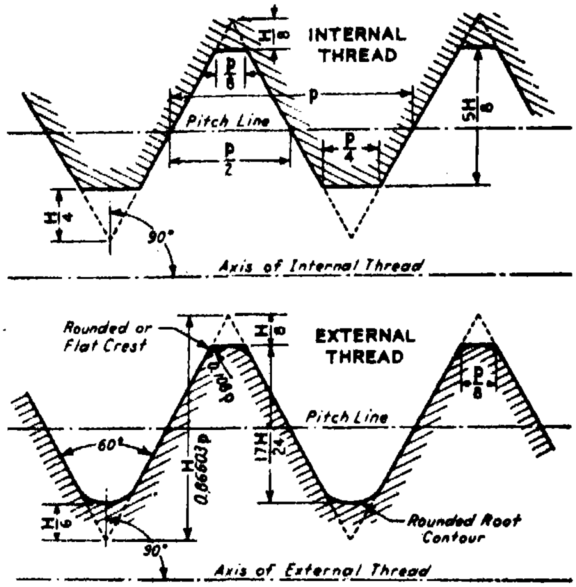


FIG. 1. Unified form of thread (maximum metal condition).

The need for adjusting these differences between the two systems must have been written and talked about almost from the very moment we adopted the Sellers thread. For years, however, nothing much was done about it. It has taken two world wars to bring all parties to the realization that action was necessary.

There are some appalling stories about the loss of time and money incurred by Allied nations because of noninterchangeable screw threads. It has been said that it took us ten months to start manufacture of the British Rolls Royce engine. Supposedly, most of that time was lost because our factories had to be specially set up to produce the British thread. Another story has it that it took six months to adapt the Bofors gun to American manufacture, largely because of thread differences. It has been estimated that the differences between the British and American threads cost the recent war effort no less than a hundred million dollars. That statement, if true, becomes all the more realistic when we think of it in terms of time, effort, and blood. These examples represent a very few of the serious situations which finally brought about the signing of the Declaration of Accord.

In fairness to all concerned, however, we owe a debt of sincere gratitude to the early leaders in the screw thread movement. Those old systems stood the test of time for over 75 years.

In the United States there has been, over the years, a great deal of criticism of our system. In developing the new standards, careful consideration was given to these complaints, and where possible the objectionable features were avoided. The new standards therefore serve a twofold purpose in providing a unified screw thread, interchangeable among Britain, Canada, and the United States, and in overcoming many of the other objections to the old standards.

It is important to note that these new standards resulted from a cooperative attack on the problem by the three governments, the producers of threaded articles and tools, and the consumers of such articles. All interests were represented. Numerous bodies, such as governmental bureaus and trade associations, other than those specifically mentioned in the Declaration of Accord, have participated over the years in this program.

The new standard is known as the Unified Thread and Fig. 4 indicates its characteristics for both internal and external threads. In comparing Fig. 4 with Figs. 2 and 3 it is immediately evident that the new form is a compromise. Certain characteristics of both the Sellers and the Whitworth forms are evident.

Note that the new thread form does not differ too greatly from the old American National form. The thread angle is the same—60°. The principal difference is at the thread root in the external thread, which is shown rounded rather than flat-bottomed. This round form is not mandatory with new tools. At the crest of the external thread, it will be noted that two forms are shown. One is rounded, which is the form preferred by the British, and will be published in their standards. The other is flat, which is preferred by the United States and will be shown in the American publication.

The various classes of thread provided in the new standards, while similar in form, differ principally by the amount of pitch diameter tolerance and allowance specified. These classes are:

External thread	*Internal thread*
1A (Allowance)	1B
2A (Allowance)	2B
3A	3B
2	2
3	3

Generally speaking, classes 1A and 1B will find their greatest application in Britain among the so-called black bolt manufacturers. In this country their greatest application will be for ordnance work, plastic molded threads, or die cast threads. Classes 2A and 2B will be the recognized standards for normal production of bolts, nuts, and screws. Classes 3A and 3B are included to provide for close tolerance work. These classes are expected eventually to replace classes 2 and 3, which were the standards largely in use prior to the signing of the Declaration of Accord. These two latter classes are not unified threads, but have been retained in the standards because of their widespread current usage. They will continue to serve through the difficult transition period from the old to the new standards.

The new standard thread dimensions overcome various faults found in the old system. The old standards took into consideration only one variable—thread pitch. The new standards consider at least two additional variables, namely, basic major diameter and length of engagement.

The tolerances and allowances of the unified threads, classes 1A, 2A, 3A, 1B, 2B, and 3B, are based uniformly upon a new empirical formula. It was developed through a study by fastener manufacturers and represents normal accuracy in present-day threading practice. This formula contains a multiplying factor, C, which is introduced to proportion the formula for the various classes of thread. Inspection of this formula will show that the tolerance or allowance depends upon three variables: the major diameter, length of engagement, and pitch of the thread.

The following formula is applied in setting up allowances on all diameters and tolerances on pitch diameter of the unified classes of threads:

Tolerance (or allowance) =

$$C(0.0015\sqrt[3]{D} + 0.0015\sqrt{Le} + 0.015\sqrt[3]{p^2}).$$

Where C = factor for each allowance or tolerance,
D = basic major diameter,
Le = length of engagement, and
p = pitch.

	Factor C	
Class	For tolerance	For allowance
1A	1.500	0.300
1B	1.950	
2A	1.000	0.300
2B	1.300	
3A	0.750	0.000
3B	0.975	

As the list of class designations shows, there is an allowance in classes 1A and 2A.

For years users of threaded articles have been plagued with the metal-to-metal contact between internal and external threads under the maximum metal conditions permitted in the old standards. The allowance in the new standard is actually a small air gap or neutral clearance between mated internal and external threads, even under maximum metal conditions. This air gap is so small as to have practically no effect upon the strength of mated members, yet it serves a useful purpose. The mass production assembly line industries in particular will be grateful for this allowance. Some of its advantages are:

1. It facilitates high cycle wrenching. In the past it has not been unusual to develop heat through friction, when power wrenches are used. This often caused the internal member to expand, and galling and seizure of the threads resulted.

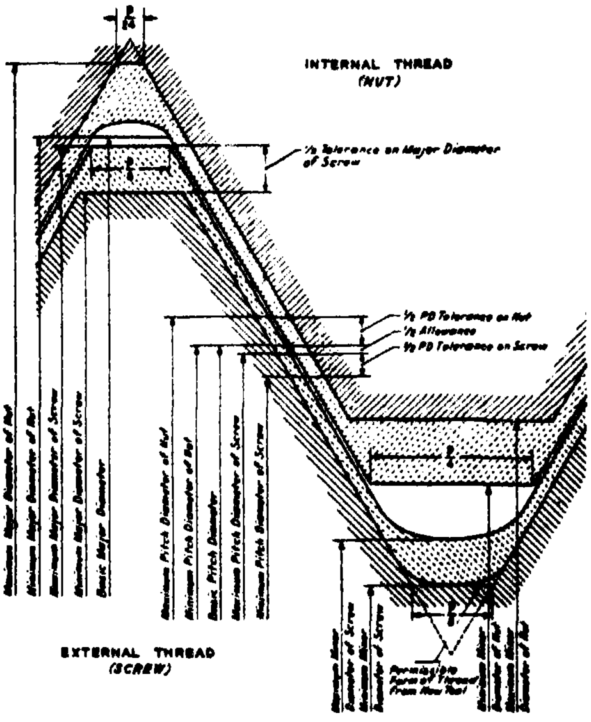

p/16
INTERNAL THREAD (NUT)
½ Tolerance on Major Diameter of Screw
½ PD Tolerance on Nut
½ Allowance
½ PD Tolerance on Screw
Maximum Major Diameter of Nut
Minimum Major Diameter of Nut
Maximum Major Diameter of Screw
Minimum Major Diameter of Screw
Basic Major Diameter
Maximum Pitch Diameter of Nut
Minimum Pitch Diameter of Nut
Basic Pitch Diameter
Maximum Pitch Diameter of Screw
Minimum Pitch Diameter of Screw
p/8
p/4
p/8
EXTERNAL THREAD (SCREW)
Permissible Form of Thread From New Tool

Fig. 5. Tolerances, allowance, and crest clearances for classes 1A, 1B, 2A, and 2B.

2. The allowance solves the problem of interference between mated members due to plating.

3. Handling of threaded articles, such as bolts, nuts, and screws, occasionally results in the burring and nicking of threads. The producer's plant may contribute a few burrs and these are added to by the wholesaler, the retailer, and finally the consumer. Excessive burrs formerly caused interference between threaded parts to be mated, but the allowance in the new standard eliminates the interference.

4. Much of the freezing of threads under conditions of elevated temperatures will be avoided.

Fig. 5 goes into greater detail as to the general contour of the new thread and shows tolerances, allowance, and crest clearances for classes 1A, 1B, 2A, and 2B.

No attempt is being made here to delve into the intricacies of screw thread theory. The scientific and engineering aspects have been in good hands and the new standard tables speak for themselves in this respect. Several articles have been published on these phases of the problem (*1–5*).

The most widely used thread class for bolts, nuts, and screws in the old standard is designated as class 2. Its related classes in the new standard are 2A for

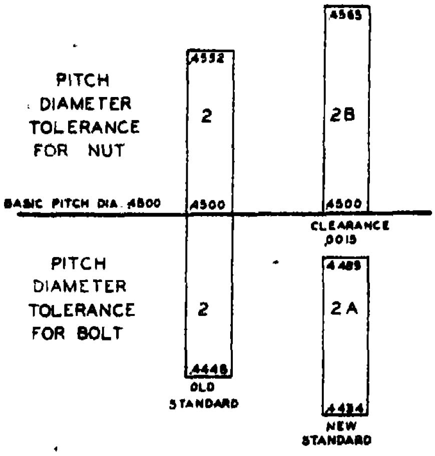


FIG. 6. Comparison of present standard class 2 pitch diameter tolerances with the new standard class 2A and 2B for ½–13 national coarse thread.

external threads, such as on bolts and screws, and class 2B for internal threads, such as on nuts. Fig. 6 gives a clear graphical example of the difference between the old and the new standards. This difference is shown for one size only, that is ½ inch, 13 threads per inch.

Tables have been compiled for the new standards, covering every conceivable screw dimension for every size and class of fit, and every thread pitch series. For example, the limiting dimensions for the ¼-inch-diameter, 20-threads-per-inch, coarse Unified and American Thread Series, class 2A, for external threads, are:

Size	¼ inch
Threads per inch	20
Thread symbol	UNC2A
Allowance	0.0011
Major diameter limits—maximum	0.2489
Major diameter limits—minimum A	0.2408 for finished and semifinished items
Major diameter limits—minimum B	0.2367 for unfinished items
Major diameter tolerance A	0.0081 for finished and semifinished items
Major diameter tolerance B	0.0122 for unfinished items
Pitch diameter limits—maximum	0.2164
Pitch diameter limits—minimum	0.2127
Pitch diameter tolerance	0.0037
Minor diameter maximum	0.1876

These few figures serve as an indication of the great amount of engineering, mathematical, and editorial work that went into the tables. It is little wonder that it took so many years to accomplish the task.

The impact of a change such as this one could very well upset the economy of the producer, distributor, and consumer of threaded articles. These three groups represent possibly 90 percent of the world's trade and commerce in manufactured durable articles. An approach to such a world-wide problem calls for extreme caution. The three principally affected groups are now faced with the problem of placing the new standards in effect. However, the job cannot be done fully in a month or a year. It has been estimated that it may take five years from the time of publication of the new tables to complete the conversion.

The producer of threaded fasteners and articles must produce and purchase the necessary new tools, dies, and gauges. If his operations are broad, he may be manufacturing in accordance with both the old and the new standards at the same time, but during the transition period he will gradually increase production of new standard parts and decrease production of the old. He will have products made with both standards in his inventory at the same time. It is fortunate indeed that the old standard threaded fasteners are interchangeable with the related new standard counterpart. If this were not true there would indeed be chaos. A photograph of a modern thread rolling machine, upon which will fall the burden of producing the new standard threads on bolts and screws, is shown in Fig. 7.

FIG. 7. Modern screw thread rolling machine.

The distributor's problem is somewhat simpler, in that he will only need to cope with his inventory, which will contain some of the old standard parts and some of the new during the transition period. Here again, the problem is minimized because of the interchangeability of the old and the new.

The consumer is the man who buys threaded fasteners or threaded articles to be assembled in his plant into manufactured durable goods—automobiles radios, washing machines, and any number of other articles. He too has a problem during the transition period. His inspection will need to cover either the old or new standard. His warehousing, manufacturing, and assembly operations will need to be flexible to accommodate both standards. He will find it expedient to accept purchased articles, during the transition period, which may have been produced in accordance with either the old or the new standard. His inspectors will no doubt be instructed to accept either standard during the transition period, regardless of which specific standard may have been ordered. It would be simple, from the consumer's standpoint, if on a certain day he could discontinue using the old and start using only new standard threaded articles, but this is obviously impractical. What might have been a complex transition, however, is made easier by the interchangeability of the old and new standard articles.

The entire problem resolves itself into the elements of time, patience, and money. The time, as noted, may be as much as five years, and the patience of both producers and consumers will be tested during this transition. The money is a real consideration—many thousands of dollars will have to be spent on new standard tools, dies, and gauges, on product identification, and on storage systems.

The new standards offer so many advantages to everyone concerned that they will be placed in effect as quickly as possible by all producers and users of threaded articles. Requests for new standard threaded fasteners are already being received from some of the leading national industries. The wheels of industry have been set in motion to accomplish this gigantic task and it may be completed much sooner than we expect.

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Solar Eruption of May 10, 1949

A. H. Shapley and R. M. Davis, Jr.

National Bureau of Standards

AN OUTSTANDING SOLAR FLARE and its effects on the ionosphere were observed in unusual detail on May 10, 1949, at the Sterling Field Station of the National Bureau of Standards. In addition to the usual magnetic variation and continuous wave radio field intensity observations that are always in progress, data were also obtained with solar noise radiometers (Wurzberg) at 480 and 160 megacycles, and rapid sequence, vertical incidence multifrequency (h′-f) observations of the ionosphere. Preliminary determinations of the times of significant activity have been communicated by Helen Dodson, of the McMath-Hulbert Observatory, who estimates the flare as of importance 3+, the greatest reportable on the scale of the International Astronomical Union.

All observations of the eruption and its absorption effects show that it began between 20:00 and 20:03 Universal Time (see Table 1). The solar burst of radio noise seems to have been detected before any terrestrial effect. Estimated errors in time determination are ± 0.25 minute for solar noise observations, and ±1 minute for ionospheric measurements. The precision of the McMath estimates is not known. The maximum effect was reached for all types of observation of the phenomenon at between 20:10.5 and 20:12.5; again the solar burst attained maximum first. The duration of the extremely intense portion of the solar noise burst lasted only two or three minutes. The severe ionospheric absorption effects lasted considerably longer, the duration being greatest for oblique incidence paths.

The intensity of the noise burst, presumably emanating from the small visibly active area, was about 290 times the normal energy output of the entire disk of the quiet sun on 160 megacycles, while the intensification on 480 megacycles was probably 1000 times the background radiation. The mirror and antenna of the 480-megacycle radiometer were not set directly on the sun at the time of maximum of the burst, so that the value given is an estimate; the possible range of intensification ratio appears to be between 800 and 1550. This is the strongest burst observed thus far with these radiometers. Minor bursts previously observed with these instruments have yielded the larger ratio at 160 megacycles.

TABLE 1

Summary of Solar-Terrestrial Phenomena of May 10, 1949

Phenomenon	Time of beginning U.T.	Time of maximum U.T.	First stage of recovery U.T.	Return to normal U.T.	Remarks
H_α flare	20h02m	20h11m	20h30m	After 22h20m	Importance 3+ (preliminary estimates)
Solar noise outburst 160 megacycles	20 00	20 10.6	20 11	20 37	Increase of solar radiation at maximum of 290 times
Outburst 480 megacycles	20 01	20 10.6	20 12	20 58	Intensification at maximum order of 1000
S.I.D. h′-f trace	20 03	20 11	20 30	After 21 11	Absorption of vertical incidence signals up to 6.5 megacycles
S.I.D. (Signal from GLH, England)	20 03	20 12	20 28	21 10	Decrease of 42 decibels
S.I.D. (Signal from W8XAL, Ohio)	20 02	20 11	21 28	22 00	Decrease of 45 decibels
Magnetic crochet	20 03		20 30	20 45	Increase of 24 gammas in horizontal intensity

The strongest outburst of energy occurred during the same period on the two frequencies. The phenomenon started abruptly on 480 megacycles (Fig. 1), with a 39-fold intensification in less than a minute. Thereafter the radiation increased in steps to the maximum. The initial postmaximum decrease was very abrupt. By contrast, on 160 megacycles the phenomenon began gradually, and then there was a 37-fold increase in about two minutes. Again decrease was rapid. The field intensity records indicate a small increase in absorption at the start of the flare, followed within three or four minutes by the abrupt increase (sudden ionospheric disturbance). The beginning of the brief disturbance, or "crochet," which appears in the magnetic recordings, is aligned with the other phenomena; no maximum can be defined.

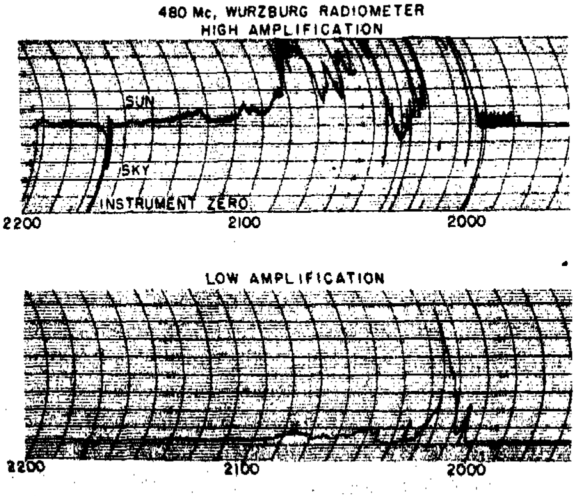

Fig. 1. Solar noise burst at 480 megacycles, May 10, 1949.

A secondary maximum of the 480-megacycle record at 20:18 coincides with a brief increase in the minimum frequency returned at vertical incidence (Fig. 2). Otherwise none of the features of the postmaximum solar records corresponds with details of the recovery stage of the fadeout. The flare had subsided, but had not disappeared, by 22:20 on spectroheliograms taken in the light of the alpha line of hydrogen. The 480-megacycle solar noise became relatively quiet much earlier (by 20:53), while on 160 megacycles, solar radiation was relatively steady after 20:37, though at an enhanced level and with minor fluctuations. Ionospheric absorption effects continued to be noticed as late as 23:00 at the very lowest transmitting frequency; for higher frequencies the effect of the disturbance had disappeared soon after 21:00.

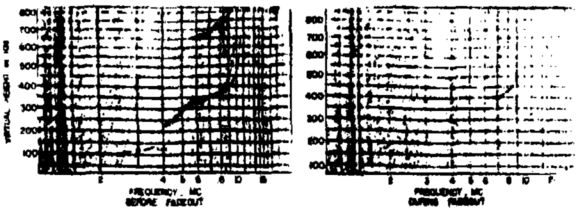

Fig. 2. Multifrequency ionospheric record at beginning of solar flare (left) and at stage of maximum absorption (right).

The flare was observed in a rather small sunspot region, with area only 450 millionths of the sun's visible hemisphere. Assuming that the radiation originated entirely in this region implies that the intensity of the source was 2×10^6 times as great as the average energy from the entire disk at 480 megacycles. This region crossed the central solar meridian on May 11.5 in latitude 18° S. An intense magnetic storm began at 06 : 24 May 12, 34 hours 22 minutes after the flare, during an interval when disturbance had been forecast by the Central Radio Propagation Laboratory.

This occurrence supports previous evidence that great flares and severe fadeouts start very nearly simultaneously. The observation that the times of maximum intensity of the bursts of solar noise at 480 and 160 megacycles coincide to within a few seconds differs from the condition observed with the lesser bursts. That this time of maximum intensity is also very nearly the time of maximum absorption is further evidence that the radiation which ionizes the absorbing layer varies in intensity similarly to radiation in the H_α and the 480- and 160-megacycle regions.

TECHNICAL PAPERS

Low Temperature Studies with Colloidal Silicic Acid

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A number of observations have been made in this laboratory during the past two years pertaining to the thermal behavior of silica sols which appear to be related to the properties of ice. The following gives a brief summary of the findings. More detailed reports will be published elsewhere.

The effect of freezing on the stability of colloidal silicic acid is known to be related to pH (*4*). An extension of the study to liquid air temperatures has revealed that the rate of thawing may have a profound effect with systems frozen at temperatures below about − 55° C (e.g. at − 65° or in liquid air). When thawed rapidly by immersing the containing vessels (test tubes) in water at room temperature the colloidal system remains stable. However, when the same system is thawed slowly in air at room temperature it coagulates.

An explanation of this phenomenon may be that the ice lattice is more disordered when formed by rapid freezing below about − 55° C than it is when formed above this temperature. Freezing the colloidal system in liquid air produces a solid system which approaches an amorphous condition (*2*). At temperatures higher than about − 55° C the ice lattice is more orderly and this causes the colloidal particles to be coagulated when they are crowded together into pockets.

When the system described above is frozen by immersion in liquid air and thawed slowly, the solid state is retained long enough above − 55° C for well-defined crystals to form. This results in the dehydration of the colloidal particles in the pockets which serve as loci for coagulation. Under conditions of rapid thawing the more stable lattice does not have a favorable opportunity to form, hence freezing and thawing do not produce coagulation under these conditions.

It has been demonstrated in a striking way that this fundamental change can occur in the solid state. A sol frozen in liquid air may be held for an undetermined length of time at temperatures below about − 55° C (e.g. at − 65° or in liquid air), and it will not coagulate if it is thawed rapidly. However, when the sol is frozen in liquid air and then transferred to a temperature above − 55° C, but substantially below the melting point, e.g. − 35° C, and held at this temperature for 15 min it coagulates irrespective of the rate of thawing. Fifteen min is a relatively short time and it is apparent that the disoriented lattice is metastable with respect to the crystalline lattice.

These observations tend to clarify the reported behavior of a variety of different systems and to strengthen the view that the properties of ice at different temperatures may be a determining factor in the stability of a colloidal system. Thus, it has been reported that hemoglobin and vanadium pentoxide sols coagulate when frozen at − 5°, − 15°, and − 21° C but not at − 190° C (*1*). The rate of thawing of synthetic rubber dispersions frozen at − 60° C has been found to have a similar marked effect on the amount of coagulation (*5*).

It is tempting to correlate the behavior described with the fact that the dielectric constant of ice diminishes abruptly at about − 55° C (*3*). On the basis of free rotation of the water molecule, it can be said that at about − 55° C a polymorphic transition from a fine ice structure with a disoriented lattice (not a glassy state) to a more orderly lattice with a higher lattice energy occurs. It is the condition of the ice above − 55° C which is responsible for the precipitation phenomena. The lattice energy under these conditions is sufficient to overcome the solvation energy.

Additional information concerning this complex behavior has been obtained by observing the freezing precipitation in the presence of alkali metal halides. Some success has been had in correlating the effect of these ions on orientation of the water molecule by hydration with their influence on the amount of coagulation during freezing. As predicted, coagulation varies with salt concentration and goes through a minimum at low concentrations. Under favorable conditions coagulation can be entirely inhibited. These effects would appear to have various biological applications.

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Antithiamine Effect of Oxythiamine and Neopyrithiamine. A Comparative Study[1]

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According to Wilson and Harris (*3*), pyrithiamine does not have the structure assigned to it. These workers have synthesized a new compound which they call "neopyrithiamine," and which shows chemical and physical properties that would be expected from the pyridine analogue of thiamine. When this compound became available,[2] an experiment was set up with a view of comparing its antithiamine effect with that of oxythiamine, which was shown in this laboratory to act as an antagonist for thiamine (*2*).

Mice of the Swiss and C-57 Black strains from our stock colony were used. The animals were placed at weaning on a thiamine-deficient diet which consisted of casein (Labco) 25%, sucrose 53%, hydrogenated vegetable oil 10%, lard 5%, Osborne and Mendel salt mixture[3] 5%, and Ruffex 2%, and contained the following supplements per kg of diet: riboflavin 10 mg, pyridoxin 10 mg, calcium pantothenate 100 mg, α-tocopherol 40 mg, β-carotene[4] 20 mg, vitamin D (Drisdol) 5000 units, and choline chloride 1.5 g. When the animals had become steady in weight, they were maintained on 1 μg of thiamine per day, injected in aqueous solution subcutaneously for one week. Daily injections of oxythiamine or neopyrithiamine were then started together with 1 μg of thiamine in a ratio (thiamine: antivitamin) of 1:50. Control animals, three for each group, received thiamine alone. The results are shown in Table 1.

In the case of both compounds the effect on the food intake was apparent overnight. There was a drop in the food intake of the animals and a loss in weight. The data show that the antivitamin effect of neopyrithiamine is more pronounced than that of oxythiamine.

TABLE 1

COMPARATIVE ANTITHIAMINE EFFECT OF OXYTHIAMINE AND NEOPYRITHIAMINE

Substance tested	No. of mice	Wt of mice at start of injections of antivitamin g	Incidence of polyneuritis %	No. of days before polyneuritis developed	Survival time in days
Oxythiamine	9	10.6–13.6	0	...	13–21
Neopyrithiamine	9	10.2–13.8	100	5–7	7–8

This manifested itself in the development of polyneuritic symptoms in the animals treated with neopyrithiamine and in a shorter survival period. The polyneuritic syndrome was similar to that described by Morris (*1*). In addition, we observed that the mice were apt to hold their heads on one side, and that they developed complete paralysis of the hind legs. The controls maintained their weight, and they survived until they were sacrificed two weeks after the last animal in the corresponding experimental group had died.

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[1] This investigation was aided by grants from the National Institutes of Health and the John and Mary R. Markle Foundation.

[2] We are indebted to Dr. K. Folkers of Merck & Co., Inc. for the neopyrithiamine.

[3] The quantity of manganese was doubled.

[4] A mixture of 90% beta and 10% alpha carotene (GBI) was used.

Mechanical Transmission of a Plant Tumor Virus to an Insect Vector[1]

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Most plant viruses transmitted by leafhoppers have not been demonstrated to be infective in extracts. The virus dealt with in this paper causes tumors in certain susceptible plants, is carried by leafhoppers, and like others in that group has proven difficult to detect in extracts. It is our purpose to recount briefly the variety of methods that failed to transmit the virus and to report on the success of insect-to-insect transmission by injection.

The virus, known as wound-tumor virus, *Aureogenus magnivena* Black (*2*), is transmitted from plant to plant by the leafhoppers *Agalliopsis novella* (Say), *Agallia constricta* Van Duzee, and *Agallia quadripunctata* (Provancher). Attempts by the authors to transmit the virus mechanically from plant to plant have been made, using various methods of inoculation, both with untreated juice from infected plants and also after the addition of materials to the juice to alter the osmotic pressure, pH, and oxidation-reduction potential with the aim of stabilizing the virus. Juice has been rubbed onto the leaves and injected into the stems and crowns of plants by different techniques. Several species of susceptible plants have been used in these experiments, but an infection has never been obtained by any of these methods. The inoculation of plants with juices from infective insects also failed to produce infection, even though such juice was proved to have infective virus when tested by the successful technique described here. Leafhoppers fed on juices from diseased plants, from viruliferous insects, and on concentrates of these juices prepared by high speed centrifugation did not become infective. It is possible, of course, that more extensive trials with these procedures or variations of them might yield positive results.

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[1] This work was supported in part by a grant from the American Cancer Society in accordance with a recommendation by the Committee on Growth, National Research Council.

[2] Fellow in Cancer Research, American Cancer Society. Present address: The Rockefeller Institute for Medical Research, New York City.

Storey (*5*) was the first to transmit a plant virus from insect to insect by inoculating virus-free vector leafhoppers, *Cicadulina mbila* Naude, with juice from insects carrying maize-streak virus, *Fractilinea maidis* (Holmes) McKinney (*5*). Using fine glass capillaries, Black (*1*) transmitted the aster-yellows virus (*Chlorogenus callistephi* H. var. *vulgaris* H.) by injecting juice from viruliferous into nonviruliferous leafhoppers (*Macrosteles divisus* Uhler). In view of these earlier successes, it seemed logical to attempt transmission of the virus by injecting healthy vector leafhoppers with extracts from insects carrying wound-tumor virus.

Three hundred and fifty nonviruliferous leafhoppers (*Agallia constricta* Van Duzee) were caged on crimson clover plants (*Trifolium incarnatum* L.) showing pronounced symptoms of wound-tumor disease and were kept there for four weeks at about 25° C. Maramorosch had previously (*4*) obtained good transmission of the virus at 25° C with this vector, after a minimum incubation period in the insect of two weeks. The insects were then collected and ground at 0° C with an equal weight of 0.25 M NaCl. The suspension was centrifuged at 3500 rpm for 5 min, and the supernatant used without further dilution for the injection of 28 virus-free nymphs. The solution was drawn up into a fine glass capillary, and a small amount forced into the insect through a puncture made in the abdomen with a glass capillary. Twelve of the 16 insects which survived the injection proved to be infective when tested on crimson clover plants. Although no controls were included in this experiment, the results are considered significant because there were no accidental infections with this virus in the greenhouse during the course of this experiment or the two previous years.

A second experiment was carried out to confirm these results as well as to obtain a first approximation of the dilution end point. An extract of viruliferous insects was prepared as in the first experiment, and 0, 10^{-1}, 10^{-2}, 10^{-3}, and 10^{-4} dilutions were made with 0.25 M NaCl. Groups of 20–30 insects were inoculated with each dilution, and an equal number of uninoculated insects were kept as controls. All insects were tested individually on two sets of crimson clover plants over a period of two months, and the plants were then observed in the greenhouse for an additional period of two months. None of the control insects became infective, but some insects inoculated with each dilution of viruliferous insect extract up to and including 10^{-3} did. There was a long incubation period before inoculated insects were able to infect healthy plants with wound-tumor virus.

These experiments show that wound-tumor virus can be detected in extracts from insects, and the experiments also make possible the determination of some of the physical and chemical properties of the virus. The fact that three leafhopper-transmitted plant viruses have proved transmissible by this method of insect inoculation suggests that the method may succeed in certain instances where other techniques have failed.

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The Chromatographic Estimation of Lysine and Some Applications of the Method[1]

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In exploring the various published chromatographic techniques, it occurred to us that paper chromatography of the copper salts of amino acids might provide a simple means of estimating some of the amino acids. The salts were prepared as described in our modification of the Pope and Stevens procedure for determination of the amino acid N (*1*) and 0.02-cc aliquots of the resulting solution partitioned on paper strips in an aqueous phenol atmosphere for 6 hr by the capillary ascent principle described by Williams and Kirby (*2*). After drying in air the strips were developed by painting with a freshly prepared 10% solution of aqueous iron ferrocyanide. The characteristic pink color of copper ferrocyanide, which appears distinctly on drying, indicates the position and relative amounts of various amino acids on the strip. Tests with 60 γ of purified specimens showed glutamic and aspartic acid to have overlapping R_f values in the area 0.06–0.10. Lysine occurred in the region 0.42–0.50. Arginine and histidine overlapped in the 0.55–0.62 R_f zone. The other amino acids, glycine, serine, threonine, valine, leucine, isoleucine, tyrosine, proline, hydroxypro-

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[1] Supported in part by funds from the Office of Naval Research.

[2] Present address: Nutritional Research Laboratory, St. Luke's Hospital, New York.

line were to be found in the zone 0.7–1.0. Tryptophane, methionine, cystine, and phenylalanine could not be identified by this technique, since they are oxidized during the partitioning process.

For our purposes the lysine band, because of its relative consistency, proved most useful. The band spread of the copper lysine salt is roughly proportional to the concentration in the range 30–60 γ of lysine. With protein hydrolyzates containing initially 0.5 mg N/cc it was found that zein gave negative tests; wheat gluten gave faintly positive tests; and casein, gelatin, lactalbumin, human hemoglobin, and fibrin gave bands which approximated roughly the lysine content of the preparations.

Fivefold concentrates of urines of adult or infants on normal diets showed the lysine concentration to be greater for the infant than for the adult. When a wheat gluten diet supplemented to contain 4% L-lysine was fed to infants, the lysine output was similar to that of an evaporated milk diet. When the infants were fed wheat gluten diet without the lysine supplement, the urine lysine level fell below the sensitivity of the test. Supplementation of this diet with 6% D-lysine caused a tremendous increase in the lysine output, which became normal on changing to 6% L-lysine. On the basis of this observation and the poor N-retention and weight changes manifested by infants maintained on the D-lysine-supplemented wheat gluten diet it would appear that D-lysine is not utilized for growth by the infant.

Blood filtrates could not be manipulated satisfactorily to give positive tests by this procedure.

Within limitations this method is a useful one, but it cannot be expected to yield better than semiquantitative results. Other metal salts of the amino acids—namely, nickel, silver, chromium, mercury, lead, and barium—are being studied to determine their chromatographic characteristics.

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Quantitative Study of Root Systems in Different Soil Types

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Study of soil-root relations of various crop plants and range grasses has lagged far behind the pressing need for an understanding of these relationships. Little progress in devising new methods for such study, at least methods that have been widely used in the field, has been made since the extensive researches by the direct method, using trench and hand pick, employed by Weaver (*1, 2*) during the period 1919 to 1926. This lack of a quantitative approach to comparative root studies in various soil types has undoubtedly been a chief reason for the dearth of more definite information on this important subject.

A new method has recently been devised by which a complete sample of an entire root system from soil surface to maximum depth of penetration may be taken, separated from the soil without injury to the root or displacement of individual roots from their natural position, and examined in the laboratory in relation to the various horizons of the soil profile. The method, applied to range grasses, consists in obtaining monoliths of soil 12 in. wide and 3 in. thick to a depth, varying with root extent, of 3–6 ft.

A trench about 3 ft wide and 4–5 ft long is dug in a site where there is normal development of vegetation. The depth is usually 4–6 ft. Beneath the particular sample of grass, previously selected and left undisturbed in the side wall, the wall of the trench is made smooth and vertical, as shown by a plumb line. A long shallow wooden box, 12 in. wide and 3 in. deep (inside dimensions), without a top and lacking one end, is employed. It is placed on end, with the closed end downward. The open top is placed against the vertical trench wall, the upper end of the box just reaching the soil surface. An impression of the sides and lower end of the box is made on the vertical wall of the trench by tapping the bottom of the box vigorously with a 4-lb sledge. The box is then removed and the soil column marked out with butchers' knives having rigid blades. The soil on the sides and below these marks is removed by means of knives and spades until the monolith protrudes from the trench wall, its sides and bottom extending outward at least 3 in. The box is then fitted tightly over the monolith and the bottom and lower end of the box are braced to hold the soil column in place. Finally, the soil on the inner, attached face of the monolith is cut away by working inward with knives and spades from each side. The soil is not cut close to the top of the box, but a V-shaped ridge of soil is left protruding throughout its length. This is a part of the sample when the braces are removed and the monolith is lifted out of the trench. The entire monolith is transported to the laboratory, where a description of the profile as regards soil texture, structure, consistence, pH, etc. is made. Only then is the monolith reduced to exactly 3 in. in thickness.

The soil is removed from the box by a process of repeated soaking, often for several days, and gentle washing, mostly under water, even when it is extremely compact or contains a claypan. A flaring rose nozzle attached to a garden hose is employed. During this process one may study the intimate relations of soil and roots. Roots are unharmed and in their natural position in the water after the soil has been washed away.

The root system is transferred to a large smooth painted board. The board is kept wet and tilted while the roots are finally washed free of any remaining soil. Excess water is then removed by large blotters and the damp root system is transferred to a mounting board covered with cloth of black felt. This is done by placing the mounting board, face downward, over the root system, holding the two boards tightly together, and inverting them. The painted board is then removed. The root system is lighted for photographing by electroflash units. It may then be dried and preserved indefinitely or cut into sections according to depth in feet or according to

FIG. 1. Portion of a root system of western wheat grass (*Agropyron smithii* Rydb.) 12 in. wide and 30 in. deep. The bottoms of the *A* and *B* horizons are marked by white lines. Only a small portion of the roots in the *C* horizon is shown.

FIG. 2. Upper 4 ft of roots of buffalo grass *Buchloë dactyloides* (Nutt.) Engelm. Upper lines mark the depth of a 12-in. fill which gradually buried the former topsoil (A_{1-1} horizon). 14 in. thick. Note excellent root development in these layers.

depth of the soil horizons it occupied. The roots are then oven-dried and weighed.

The root system in Fig. 1 was taken from Butler silt loam soil 28 in. deep, overlying deep, friable, silty clay loam parent material. The *A* horizon, which is only 7.5 in. thick, contained 67% of the roots by weight. Roots were poorly branched in all but the lower part of the claypan or *B* horizon. Most of the branching occurred in the *C* horizon of less compacted, friable silty clay loam. Roots in the 13 in. below the point of heavy branching weighed 36% more than the 13 in. of poorly branched roots above. The root system in Fig. 2 was taken from Wabash silt loam in a valley between two loess hills. Although the grass is normally only 4–5-in. tall, the roots are 5–6 ft deep.

Descriptions have been made of the profiles of 16 soil types, from which 11 species of grasses were taken in a total of 33 monoliths in 1948.[1] The depth, density, and weight-distribution of roots of the same species in different soil types and of different species in the same soil type have been ascertained. Quantitative data on root distribution in the several soil horizons have also been obtained. The effect of buried profiles on root habit has been examined, as have modifications resulting from the loss of one or more soil horizons by erosion. A detailed account of the work is in press.

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A Simple Micromanipulator

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For the isolation of one microscopic cell a fine capillary pipette is often used, the point of which is inserted into the drop of fluid containing the organisms; under microscopic control a single cell can then be sucked into the capillary pipette. The difficulty of this operation consists in keeping the point of the pipette motionless. at a magnification of, say, 100 times, in front of the organism, which in many cases has a size of only 10–25 μ.

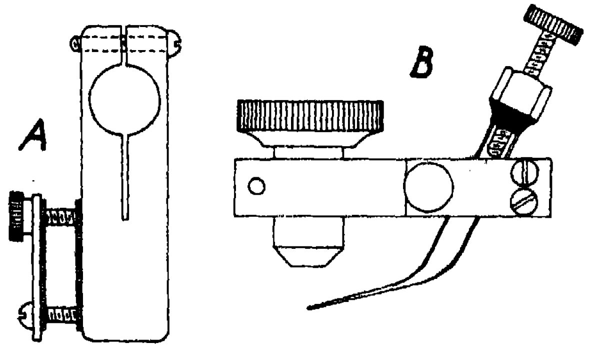

FIG. 1. A. Micromanipulator top view without the capillary pipette. B. Micromanipulator with the capillary pipette, side view, mounted on the objective of the microscope. Three-fourths natural size.

The device described here is one whereby the pipette can be fastened to the objective of the microscope. By means of the mechanical stage of the microscope, the organism can then be moved to the mouth of the fastened capillary pipette and sucked up.

As shown in Fig. 1, the apparatus may consist of a block of metal 55 mm long, 15 mm broad, and 10 mm high, or to avoid scratches on the side walls of the objective, of a corresponding piece of ebonite or plastic used for insulating purposes by the electrical industry. In one end, there is a vertical hole for the objective, and a deep incision so that the walls of the hole can be fastened around the objective by means of a threaded bolt. On the side wall of the other end is placed a retaining plate, so that the capillary pipette can be pressed against one vertical wall of the block by means of three screws. Small pieces of felt or thin plates of cork glued to the walls of the block and the retaining plate prevent breaking of the pipette.

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[1] Profile descriptions were made by Mr. James Thorp, Principal Soil Correlator, Great Plains States Division of Soil Survey, U. S. Dept. of Agriculture.

The capillary pipette is a 5-mm glass tube, one end of which has been drawn into a long, thin point and bent to form an angle of about 135° with the tube. At the other end of the tube, a small but high nut with a threaded bolt to match is fastened by means of glass cement. It is very important that the bolt should fit exactly into the thread of the nut and that it is greased with a heavy lubricant of the kind used for glass stopcocks of burettes, in order to make a completely air-tight connection. It is desirable to have a set of capillary pipettes, the points of which are 25, 50, 100, and 500 μ thick respectively.

When the apparatus is to be used, the block is fastened to the objective, after which the capillary pipette chosen is placed in such a position that the mouth of the pipette is clearly visible in the center of the field of vision (magnification about 100 times) and the point is nearly horizontal.

If a single microscopic organism is to be selected from a fluid suspension of organisms, it cannot be done by lowering the empty capillary pipette into the drop on the slide. The capillary action, which increases with the diminishing diameter of the pipette, will immediately carry fluid with numerous organisms into the tube. The pipette must be allowed to suck up sterile water and by turning the threaded bolt a convenient column of water remains; if the pipette is then let down into the suspension by lowering the tube of the microscope, no organisms will be sucked up. By means of the mechanical stage the slide is now placed in such a position that the organism selected is situated before the mouth of the pipette; a slight counterclockwise turning of the threaded bolt of the capillary pipette will then carry the cell into the pipette, after which the capillary pipette is removed from the suspension containing other organisms by raising the tube of the microscope.

If an organism is wanted for the cultivation of a clone, the following procedure may be used. After the selection of one cell, the slide with the suspension is replaced with a sterile slide, on which a sterile cover glass is placed. The tube of the microscope is lowered until the point of the capillary pipette touches the cover glass; a slight clockwise turning of the threaded bolt will now eject a droplet of water containing the chosen cell onto the cover glass. At a magnification of, say, 200 times it should now be ascertained that the droplet contains one and only one cell. If this is the case, the cover glass can be slipped from the slide into the sterile fluid in which the species is to be cultivated.

The apparatus can also be used for making permanent slides of new or rare species, where only a few individuals were found among many others, for instance, desmid individuals in a plankton sample. Some drops of glycerine should be added to the sample, which is then placed on a watch glass or in a salt cellar to allow a slow evaporation of the water. The specimens wanted can now be selected from the glycerine suspension and placed in a droplet of pure glycerine on a slide for the usual method of preparing the slide.

Pterin-like Pigment Derived from the Tubercle Bacillus. Fluorescence and Absorption Spectral Data for Erythropterin-like Pigment Isolated by Ultrachromatographic Analysis

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The pterins are pigments having a purine or pyrimidine type of structure that were isolated from the wings of butterflies and from the integument of other insects, first by Hopkins (*5*) and later by H. Wieland and his collaborators (1925–1944), and by Schöpf and Becker (*11*), and others. These pigments usually occur as mixtures, have no melting points, and cannot be transformed into derivatives with definite melting points. Hence, they present exceptional difficulties in their separation and purification. The determination of absorption spectra was one of the criteria used, in the studies cited, as tests in successive stages of purification, and in order to characterize the different pterins derived from different sources (*11*).

We present evidence in this report that pterin-like pigments have been isolated from the tubercle bacillus which, to our knowledge, have not heretofore been reported for this microorganism. Fluorescence and absorption spectral data and other physical characteristics are given for material obtained from the acetone and other extracts of dried virulent human tubercle bacilli[1] after they had been washed with large quantities of sterile distilled water. This treatment is one of the steps in the preparation of antigens used in the complement-fixation test for tuberculosis (*14b*).

Observations in ultraviolet light were made of zones (some not visible in daylight) formed when a few drops of the extracts were placed on the margin of the thin wedge of an adsorbent such as aluminum oxide, standardized according to Brockmann (*1*) by Merck, hereafter called alumina. These zones yielded fluorescence other than the red fluorescence that may be attributed partly to porphyrin and the yellow fluorescence of flavin reported in our previous studies (*4*). This micromethod (*2*) indicated the practicability of separating some of the materials on chromatographs of alumina.

Numerous exploratory experiments indicated that a better separation of zones was effected by the use of benzine-ether 1 : 1 and chloroform solutions of the residues of ether and acetone extracts than with the original extracts. In some of the experiments the extracts were partitioned with immiscible solvents prior to placing them on chromatographs. The yield of material from the different zones was in each case very small. Hence, it was not possible to make all of the various characterizations that were reported by Schöpf and Becker for the much greater quantities of pigment that they extracted from the wings of a million butterflies. Our material has been used chiefly for the determination of absorption and fluorescence spectra. These spectroscopic data and observations of the general chromatographic behavior and patterns of the various zones when the chromatographs are developed closely parallel those reported for pterins from butterflies, as do certain other characteristics.

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[1] Human tubercle bacilli strains #18 and #48180 were grown for 3–4 weeks in glycerol broth which consists of beef, 450 g; peptone (Fairchild's), 10 g; sodium chloride, 5 g; glycerol, 50 g; and water, 1000 g (*14a*).

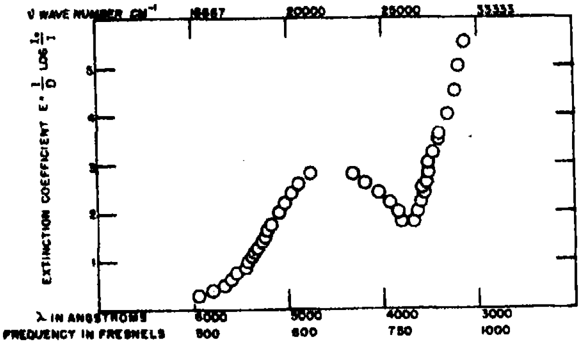

FIG. 1. Ultraviolet absorption spectrum curve. Erythropterin-like pigment (in chloroform) isolated from human tubercle bacillus.

The number of fluorescing pigments revealed on our chromatographs and the reported difficulties of separating them preclude an exhaustive study of all at this time. Observations have been focused mainly on the material from the dark velvet brown fluorescing zone (orange-red in daylight and the only one clearly visible), which has many other characteristics similar to those reported for erythropterin (*11*).

The ultraviolet absorption spectrum curve for this pigment in a limited range (Fig. 1) shows a band at about λ 4540 A. Exploration of the shorter wavelength region revealed a band at about λ 2375 A and an inflection between λ 2900–3200 A, indicating selective absorption in the same wavelength positions reported by Schöpf and Becker for an erythropterin preparation (*11*).

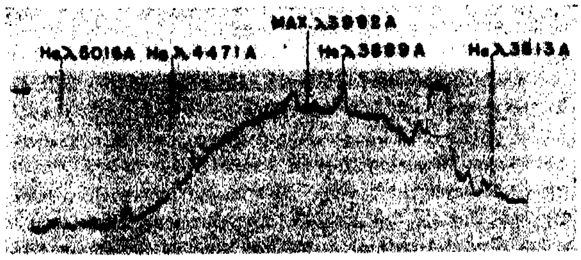

FIG. 2. Microphotometric tracing of a fluorescence spectrogram of erythropterin-like pigment (in chloroform) isolated from *human* tubercle bacillus.

A violet fluorescence in dilute ammoniacal solutions of erythropterin and changes in the fluorescence with changes in pH values have been observed (*11*). We also have noted similar fluorescence with the pigment recovered from the orange-red zone. A microphotometric tracing of the fluorescence spectrogram (Fig. 2) shows an emission band extending from λ 3580 to 4635 A with a maximum at λ 3992 A.

The chromatographic behavior on a column of alumina has been reported (*11*) for a mixture of several pterins —erythropterin, chrysopterin, xanthopterin, etc. The erythropterin is adsorbed at the top of the column as a velvet brown fluorescing zone, chrysopterin as a yellow-green fluorescing zone just below the erythropterin and above the yellow fluorescing xanthopterin zone. Moreover, a brilliant light violet-blue fluorescing zone usually appears in juxtaposition with the velvet brown fluorescing zone and is ascribed by Schöpf and Becker to a transformation product of erythropterin. We also have observed this sequence of zones on our chromatographs. The medium which is used in the cultivation of the tubercle bacillus, when concentrated ten times and passed through columns of alumina, did not show this zone formation. However, the effect of strain differences and of variations in medium are being investigated.

Erythropterin, as reported by Schöpf and Becker (*11*), is precipitated from N ammoniacal solution by treatment with N HCl as a fine red powder that is easily soluble in water. On evaporation of the solution the residue is amorphous. An ammoniacal solution of the pigment, when treated with an ammoniacal solution of silver nitrate, yields a fine dark red precipitate, which when heated turns brown, then black. Erythropterin gives no murexide reaction. It is soluble in concentrated nitric acid; but is quickly destroyed and the dark red solution becomes colorless (*11*). We also have observed the same characteristics for the erythropterin-like pigment isolated from the tubercle bacillus.

The wavelength positions of selective absorption, the fluorescence characterization, chromatographic behavior, and many other reactions observed for our material are similar to those reported by other investigators of pterins (*5, 11*). Hence the presence is indicated of a new group of pigments not previously reported to be isolated from the tubercle bacillus. A more detailed report will be published later.

We also have reported the isolation of pterin-like pigment from the diphtheria bacillus (*3*). Members of the pterin group of pigments have been found in animal and human urine (*8*), mammalian tissue (*9*), and in argentaffine cells in the epithelium of the stomach and intestine, with the same localization as that of the substance active against pernicious anemia (*6, 7*). Studies have been made of the activity of pterin in preventing clinical anemia (*13*), and also in the field of nutrition by Totter and colleagues (*12*), Pritchard (*10*), and numerous other workers. Such investigations, if further substantiated and extended, will result in the pterins' becoming of wide interest and importance in the fields of biological and medical research.

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Serum Lipase and Alloxan Diabetes in Rats[1]

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It was found by Cantor, Tuba, and Capsey (*1*), that the production of alloxan diabetes in the adult male albino rat is paralleled by a pronounced increase in the activity of serum alkaline phosphatase. The development of the diabetic condition is usually accompanied by a marked transient lipemia, which appears about two days after the injection of alloxan and which then decreases after approximately a week. It seemed probable that the existence for several days of a severe lipemia might be reflected in altered serum lipolytic activity, and this paper presents our observations with the enzyme which hydrolyzes tributyrin. This enzyme, given a variety of names in the literature, will be called lipase, although it could equally well be called tributyrinase (*2*).

Twenty adult male rats were starved overnight and in the morning each was given a subcutaneous injection of 16 mg of alloxan monohydrate for each 100 g of body weight. The animals were fed Purina Fox Checkers and water ad lib. As a result of alloxan injection, diabetes was produced in fifteen rats; three of the animals died, while two recovered from the initial hyperglycemia.

Blood for glucose and lipase determinations was taken from the tails of the animals always at 8 A.M. Blood glucose was estimated by the method of Reinecke (*3*). Lipase activity was determined within 24 hr after the serum was obtained although the enzyme was found to be stable for several days in a refrigerator. The enzyme concentration of the sera was determined by a micromethod which will be described fully elsewhere. Essentially it consists of estimating by titration with NaOH the acid set free from tributyrin by the enzyme contained in 0.1 ml serum. Hydrolysis of the finely dispersed substrate proceeds for 30 min at 37° C in an aqueous digest buffered with sodium diethylbarbiturate at pH 7.9. The lipase activity of a serum in units is equivalent to the number of ml of 0.025 N NaOH required to neutralize the butyric acid which would be set free by the enzyme contained in 100 ml of serum under the above experimental conditions. One ml of 0.025 N NaOH is equivalent to one lipase unit. The normal mean value for serum lipase in 30 adult male albino rats was found to be 556 ± 70/100 ml, with a range from 390–690 units/100 ml. Activity of the enzyme in individual rats varies slightly from day to day, but levels are not appreciably altered by starvation for 5 days.

The effect on serum lipase activity of alloxan is indicated in Table 1. Results for the group of 15 diabetic rats are available for 7 days after the onset of hyperglycemia and this information is supplemented for longer periods of time as indicated in Table 1.

TABLE 1

EFFECT OF ALLOXAN ON SERUM LIPASE OF ADULT MALE RATS

Time after alloxan injection	Blood sugar (mg/100 ml)		Serum lipase (units/100 ml)	
	mean	range	mean	range
0	117	90–120	556 ± 70*	390– 690
1 day	369	315–450	536 ± 102	320– 720
3 days	544	230–800	541 ± 80	410– 750
5 days	434	260–670	686 ± 105	510– 890
7 days	429	314–630	800 ± 67	690– 880
21 days†	426	400–450	830 ± 92	760–1000
3 months‡	350	250–400	930 ± 238	930–1400

* The values following the ± sign represent the standard deviation.

† These values were obtained from seven of the group of 15 rats.

‡ These values were obtained from a group of five animals for which there are no normal values.

Blood sugars reach diabetic values within the first day in the usual way, but the effect on lipase follows a different pattern. Almost without exception, individual rats showed a temporary fall in serum lipase levels between the first and third day after injection with alloxan. By the end of the seventh day, however, there was in every diabetic animal a definite increase of the enzyme, with an average increase to about 40–45% above normal levels for the group of 15 rats. The results given in Table 1 for rats diabetic for periods of time up to 3 months indicate that the enhancement in lipase activity of rat serum is persistent and may reach concentrations as much as 65% above normal. The development of increased lipase levels roughly parallels the appearance of high alkaline phosphatase values in alloxan diabetic rats.

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[1] This investigation was conducted with the assistance of a grant to Jules Tuba from the Division of Medical Research, National Research Council, Ottawa, and is part of Project M.P. 211.

Growth-regulating Substances in *Laminaria agardhii*

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Growth-regulating substances have been reported from nearly all major groups of the plant kingdom, but in the lower forms little is known of their role in the differentiation of thalli. The presence of a large, differentiated lamina in *Laminaria agardhii* Kjellman, formed from a well-developed intercalary meristematic region, suggested to the author the possibility that IAA (indoleacetic acid) might behave as a growth-regulating substance in this brown alga just as it does in the embryonic apical parts of vascular plants.

Along the southern New England coast this kelp develops laminas which are commonly over 5 ft in length and 8 in. broad. Young laminas are thin and homogeneously flattened, but mature laminas are thick, with peripheral parts undulating from alternate depressed and raised portions. For this investigation, plants were collected during June and July of 1948 from several habitats in the vicinity of Woods Hole, Massachusetts.

TABLE 1

Percentage Gain or Loss in Wt of Disks from *Laminaria agardhii* after 16 Days' Culture in Indoleacetic Acid Solutions

IAA in sea water mg/l	Series A Total wt 3554 mg	Series B Total wt 1490 mg	Series C Total wt 920 mg
0 (control)	+ 13% (healthy)	+ 10% (healthy)	+ 5% (healthy)
0.1	disintegrated	+ 16% (healthy)	+ 8% (healthy)
1.0	disintegrated	+ 5% (healthy)	+ 23% (healthy)
2.0	disintegrated	- 20% (fair)	- 10% (fair)
5.0	disintegrated	disintegrated	- 15% (fair)
10.0	disintegrated	disintegrated	- 80% (unhealthy)

According to Fritsch (*1*), the principal formative region in all laminarias is situated in the transition zone between stipe and lamina. From this region 120 disks of living tissue of *Laminaria*, measuring 6 mm in diameter, were used in test series A. Series B consisted of 120 disks from the middle and distal third of laminas; and series C, of 120 disks from the distal third and thin periphery of laminas. An effort was made to get random samples from plants with laminas at a developmental stage just prior to formation of the undulating periphery. The 120 disks of each series were distributed in lots of 20 to liter beakers containing sea water and various concentrations of IAA. A temperature range of 18–21° C was maintained by setting the beakers in running water. Each beaker was covered by a glass plate to reduce contamination and evaporation. Disks were blotted between filter paper before each weighing, which was done on an analytical scale accurate within 1 mg. The blotted weights of disks in any one series were rather uniform.

From Table 1 a gradient for tolerance of IAA is shown by the response of cultured tissue. The rate of poisoning and disintegration in IAA solutions varies greatly with each series, being greatest in series A, less in series B, and least in series C. Apparently IAA is supplied by the alga itself and the disks injured come from regions already containing so much IAA that addition of any more produces an injurious excess.

Because of these results a hormone test was performed. The bending of the *Avena* coleoptile for detecting the presence of growth-promoting auxins in vascular plants is a standard procedure, but except for the method used by Leonian (*2*) with fungi, the author does not know of any procedure for demonstrating the presence of minute quantities of auxin in algae. A crude extract in petroleum ether was prepared by soaking dried macerated tissue from the formative region. The ether extract was mixed with lanolin paste and evaporated. Oat seeds were germinated in the dark between moist filter paper and the inside of liter beakers. The crude extract of kelp was applied by a fine glass needle. After 8 hr, but more pronounced after 17 hr, the following results were noted: Seedlings with kelp extract applied on the outside bent toward the center of the beakers; those with extract applied on the inside bent away from the center, and those without extract treatment and those treated with lanolin only continued to grow straight.

The results of this investigation indicate that growth substances, similar to or the same as indoleacetic acid, formed in the meristematic region of *Laminaria agardhii*, may be at least partly responsible for the mature pattern of growth in the lamina, and that the natural growth-regulating substances in this alga have some physiological properties in common with those of higher vascular plants.

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[1] The author acknowledges the assistance in this research of Mr. Ko Ko Lay, graduate student at Washington University.

Comments and Communications

Dramamine and Motion Sickness

I should like to comment on the two articles on motion sickness by Gay and Carliner and Strickland and Hahn that appeared in your April 8th issue (*Science*, 1949, 109, 359).

Gay and Carliner's procedure of dividing the subjects into control and medication groups on the basis of the ship's compartments they occupied may be expeditious from an administrative standpoint but is hazardous experimentally. The various compartments of a ship are not subjected to the same degree and kind of motion. It is, therefore, difficult to ascribe the differences in sickness rates found in the several compartments solely to the medication employed. It is quite possible, for instance, that compartment 3-F was more conducive to causing seasickness than compartment 3-E. To have controlled this adequately, the investigators should have randomly divided the men in each compartment into the various experimental groups.

The procedure of using sick men in a placebo group to test the efficacy of a remedy in curing the already sick can be safely done only if a like number of sick men in the same group remain untreated or continue to receive placebos. Drs. Gay and Carliner, by neglecting this, left themselves without adequate controls and therefore one cannot determine with certainty to what extent the remission of symptoms was due to medication (Dramamine), change in weather and sea conditions, or to the phenomenon of adaptation. The latter is of great importance.

Studies of the efficacy of a remedy must be made under a variety of sickness rates and the results should be expressed as the percent protected for a given sickness rate. At placebo rates of between 20 and 30 percent—the rate apparently found in the Gay and Carliner experiment—it is not uncommon for medication such as hyoscine, or even certain barbiturates, to give high protection. With such moderate sickness rates in the controls this writer has, on occasion, found 0.6 mg hyoscine to give 80 to 90 percent protection. Therefore, on the basis of the single experiment reported, no convincing evidence is presented to indicate that Dramamine is any more effective than 0.6 mg hyoscine in preventing motion sickness. This is further borne out by the paper of Strickland and Hahn in which they report an experiment where 55.6 percent of the placebo group became sick. Under this moderately high sickness rate, 28.7 percent of a like number receiving Dramamine became sick, indicating that the medication gave protection to about 50 percent. With such sickness rates in the controls, 0.6 mg hyoscine has been shown to give similar protection (*Amer. J. Physiol.*, 1946, 146, 458). Incidentally, this dosage of hyoscine has been demonstrated to be without any harmful side effects on the efficiency of combat men.

Therefore, until Dramamine, or any other proposed remedy, is tested under adequately controlled conditions, against hyoscine as well as a placebo, and under conditions of a variety of sickness rates in the controls, any claims as to its superiority as a preventive are apt to be premature.

Finally, the statement in the opening paragraph of the paper by Strickland and Hahn, "Investigations on motion sickness in the past have shown a paucity of controlled studies carried out on shipboard or on aircraft," leave many of us who were connected in one way or another with the Subcommittee on Motion Sickness of the Committee on Medical Research a little dismayed, to put it politely. An enormous amount of time and energy had been spent on this problem during the war and much was accomplished. Also, many had the satisfaction of seeing or hearing of the results of their studies being successfully applied in landing operations. These studies, sponsored by the CMR, were the subject of numerous reports to the Surgeon General. They are also to be found in many easily available scientific and medical journals. I and, I am sure, any of the members of the wartime Subcommittee on Motion Sickness of the OSRDcmr, would be glad to enlighten the Surgeon General's office on this matter.

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Carnegie Institution of Washington

In Criticism of Chisholm's "Social Responsibility"

If no workable plan for peace can be based on the anomalous idea that social processes are the outcome of individual attitudes and decisions, then a retort seems badly needed to the endorsement (*Science*, 1949, 109, 264) of the Chisholm article "Social Responsibility" (*Science*, 1949, 109, 27). This fallacious individualism leads to *der Fuehrerprinsip*—the belief that personal leadership by "mature" or "socially minded" persons is the basis of an orderly human society.

Much more space than this note can command should be given to serious refutation of such an idea. In a world in which "the poor always ye have with you," individual responsibility is a preoccupation with keeping the wolf from one's own door. If our social setup is working badly it is because the rules of the game are badly designed to encourage and reward this acceptance of personal responsibility for one's own welfare (see "Individualism; True and False," chapter in F. A. Hayek's *Individualism and the economic order*, 1948).

The spreading of the idea that science is an "endless frontier" which can provide for any number of *Homo sapiens*, all of whom can survive as winners in the game of life if we can develop a race of "brother keepers," obviously begets anything but good sportsmanship in the morale of those who are not winning their way into the promised land of milk and honey. Such utopian materialism is directly responsible for the current war psychology, for we are eternally looking for a scapegoat—always the other fellow is this dog in the manger—when we couple personal responsibility with the fact that the promised land is not in sight.

From a truly impersonal, scientific angle, we'd do well to think through these Malthusian problems, starting from the observation of Boulding (*Sci. Mon.*, 1949, 68, 239) on the fallacies of composition and aggregation which obscure the fact that "the real world . . . cannot be understood by any generalization from individual experience." Note how this agrees with the contention of Leslie White (*J. Wash. Acad. Sc.*, 1947, 37, 181–210; also *Sci. Mon.*, 1948, 66, 235) that the individual is the creature, not the creator, of his culture; which leads us to the conclusion that "there is now only one basic importance in the world . . . on which the very existence of the race depends" (in the interest of the scientific spirit we must now reverse the Chisholm *ex cathedra* statement)—"the importance of an [un-]emotional relationship between the people of the world," based upon a justice that is blindfolded to persons and is using only an insensate mechanism. The last word has not been said on Adam Smith's "unseen hand," not even by Hayek in his masterful discussion of how the money-price system controls "The Use of Knowledge in Society" (*Amer. Ec. Rev.*, Sept. 1945).

ALDEN POTTER

Bethesda, Maryland

Association Affairs

The thirtieth annual meeting of the Pacific Division, AAAS, was held in Vancouver, Canada, June 13–16, with 537 registered members and guests in attendance. This, the first Canadian meeting of the Pacific Division, was held on the campus of the University of British Columbia, and inasmuch as it came between terms, it was possible to house the delegates in the living accommodations normally available to students.

Campus cafeterias and the Faculty Club provided excellent meals, and larger gatherings such as the general reception and the biologists' dinner were competently handled in Brock Memorial Hall. The University Extension looked after registration and assignment of rooms, dispensed information, provided projection equipment where and when needed, and took care of other miscellaneous problems as they turned up. All of this made for a compact, well-integrated meeting, and pointed to much foresight and excellent organization by the local committee.

Scenery is, perhaps, only an incidental adjunct of a scientific meeting. But it would be improper not to mention that the University of British Columbia occupies a location of breath-taking beauty, a promontory looking out across many square miles of seascape—Burrard Inlet and Howe Sound—to a backdrop of high, snow-covered mountains. The visitors were not too preoccupied with scientific matters to take note of this.

Forest ecologists had a chance to study forests. Seashore biologists went on a field trip at low tide. For fisheries, biologists, and oceanographers, the Canadian Government made two boats available, one to demonstrate new oceanographic equipment and methods, the other to demonstrate trawling.

There were three general evening sessions. At the first of these L. S. Cressman, of the University of Oregon, as retiring president of the Pacific Division, gave an address on "Early Man in the Pacific Northwest." D. S. Rawson, of the University of Saskatchewan, spoke at the second on "Scientific Fish Harvesting in Great Slave Lake." At the third, William J. Robbins, director of the New York Botanical Garden, discussed "Growth, Normal and Abnormal."

The Divisional Symposium, held Monday afternoon, June 13, had for its general subject, "Anthropology and its Applications to Society." David French, of Reed College, discussed "Anthropological Research in the War Relocation Authority"; H. G. Barnett spoke on "Social Research for Administrative Uses"; and R. F. Spencer, of the University of Minnesota, took for his topic "Immigrant Culture and Acculturation."

Another general symposium was arranged by the Pacific Science Board of the National Research Council on the general subject, "Research Plans for the Pacific Area, with Special Reference to the Seventh Pacific Science Congress." The speakers and their topics were: E. W. Gifford, University of California, "Anthropological Problems in Fiji"; Pierre Dansereau, University of Montreal, "Research Plans Developed at the Seventh Pacific Science Congress, Relating to Natural History and the Protection of Nature"; John P. Tully, Pacific Biological Station, Nanaimo, B. C., "Plans and Needs for Oceanographic Research as Discussed at the Seventh Pacific Science Congress"; R. C. Miller, director, California Academy of Sciences, "Some Problems of Population, Food and Available Resources in the Pacific Area."

The wide range of interests represented in this convention are well indicated by the symposia arranged by various societies on such topics as the following: "The Role of Chemistry in Pacific Northwest Industry," "Minor Element Nutrition in Western Soils," "Why Plants Grow Where They Do," "New Methods of High Speed Oceanographic Research," "Factors Influencing the Success of Reproduction in Anadromous and Shore Spawning Fishes," "Some Aspects of Fire in Natural Communities," "What Has Ecology Contributed to the Management of Natural Resources of the West?"

A circumstance much appreciated both by the Pacific Division and by the host institution was the presence throughout the meeting of the national president of the AAAS, E. C. Stakman, and the administrative secretary, Howard A. Meyerhoff. Through conferences, informal addresses, and meetings with the Council and the Executive Committee of the Pacific Division, they contributed greatly to the success of the meeting and to the permanent values to be derived from it.

The following societies, meeting in conjunction with the Pacific Division, held programs for the reading of scientific papers: American Chemical Society (Pacific Intersectional Division), American Meteorological Society, American Nature Study Society (Western Section), American Phytopathological Society (Pacific Division), American Society for Horticultural Science (Western Section), American Society of Ichthyologists and Herpetologists (Western Division), American Society of Limnology and Oceanography, American Society of Plant Physiologists (Western Section), Association of Pacific Coast Geographers, Botanical Society of America (Pacific Section), Cooper Ornithological Club (Northern Division and Southern Division), Ecological Society of America (Western Section), Herpetologists' League, Pacific Northwest Bird and Mammal Society, Pacific Science Board of the National Research Council, Society for Experimental Biology and Medicine (Pacific Coast Branch), Society of American Bacteriologists (Southern California Branch), Western Society of Naturalists, and Western Society of Soil Science.

The British Columbia Academy of Science, an affiliated society of the AAAS, gave up its annual meeting for 1949 in order to participate more fully in the Vancouver meeting of the Pacific Division.

ROBERT C. MILLER

Secretary, Pacific Division, AAAS

Scientific Book Register

ALBERT, ADRIAN. *Solid analytic geometry.* New York: McGraw-Hill, 1949. Pp. ix + 162. $3.00.

ASHFORD, MAHLON. (Ed.) *Trends in medical education.* (New York Academy of Medicine, Institute on Medical Education, 1947). New York 22, N. Y.: Commonwealth Fund, 1949. Pp. xiv + 320. $3.00.

BARLOW, H. M. *Micro-waves and wave guides.* New York 19, N. Y.: Dover Publs., 1949. Pp. x + 122. (Illustrated.) $1.95.

BEGUN, S. J. *Magnetic recording.* New York (16), and Toronto: Murray Hill, 1949. Pp. x + 242. (Illustrated.) $5.00.

BIRKHOFF, GARRETT. *Lattice theory.* (Rev. ed.) (American Mathematical Society Colloquium Publications, Vol. XXV.) New York: American Mathematical Society, 1948. Pp. xiii + 283. $6.00.

BURK, R. E. and GRUMMITT, OLIVER. (Eds.) *Recent advances in analytical chemistry.* (Frontiers of Chemistry, Vol. VII.) New York: Interscience, 1949. Pp. vii + 209. (Illustrated.) $4.50.

BURROW, TRIGANT. *The neurosis of man. An introduction to a science of human behavior.* New York: Harcourt, Brace, 1949. Pp. xxvi + 428. (Illustrated.) $7.50.

CARINGTON, WHATELY. *Matter, mind, and meaning.* New Haven, Conn.: Yale Univ. Press, 1949. Pp. xx + 257. $3.75.

FRIEDLANDER, GERHART, and KENNEDY, JOSEPH W. *Introduction to radiochemistry.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xiii + 412. (Illustrated.) $5.00.

GATES, R. RUGGLES. *Pedigrees of negro families.* Philadelphia, Toronto: Blakiston, 1949. Pp. vii + 267. (Illustrated.) $5.50.

LEIGHTON, ALEXANDER H. and DOROTHEA C. *Gregorio, the hand-trembler: a psychobiological personality study of a Navaho Indian.* (Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. XL-No. 1.) Cambridge, Mass.: Peabody Museum, 1949. Pp. xiv + 177. $2.50.

LIND, L. R. (Trans.) *The epitome of Andreas Vesalius.* New York: Macmillan, 1949. Pp. xxxvi + 103. (Illustrated.) $7.50.

MATSEN, F. A., MYERS, JACK, and HACKERMAN, NORMAN. *Pre-medical physical chemistry.* New York: Macmillan, 1949. Pp. viii + 344. (Illustrated.) $4.75.

MERTON, EGON STEPHEN. *Science and imagination in Sir Thomas Browne.* New York: King's Crown Press, Columbia Univ., 1949. Pp. viii + 156. $2.50.

NATIONAL HEALTH ASSEMBLY. *America's health: a report to the nation.* New York: Harper's, 1949. Pp. xiv + 395. $4.50.

NONIDEZ, JOSE F., and WINDLE, WILLIAM F. *Textbook of histology.* New York: McGraw-Hill, 1949. Pp. xiii + 456. (Illustrated.) $6.75.

RAPPAPORT, F. *Rapid microchemical methods for blood and CSF examinations.* New York 16, N. Y.: Grune & Stratton, 1949. Pp. xviii + 404. (Illustrated.) $8.75.

REMICK, A. EDWARD. *Electronic interpretations of organic chemistry.* (2nd ed.) New York: John Wiley, 1949. Pp. vii + 600. $6.00.

THORNDIKE, ROBERT L. *Personnel selection: test and measurement techniques.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. viii + 358. $4.00.

VAN HOOK, ANDREW. *Sugar: its production, technology, and uses.* New York: Ronald Press, 1949. Pp. ix + 155. (Illustrated.) $3.00.

NEWS and Notes

Senator O'Mahoney's amendment to the independent offices appropriations bill HR 4177, calling for full FBI investigations of all fellows under the program of the Atomic Energy Commission (*Science*, July 22, p. 103), was approved by the Senate on August 2. The entire bill is now the subject of a Senate-House conference, but there seems to be no doubt that the amendment will be incorporated into the final act that is passed by both houses. Inasmuch as all recipients of fellowships must undergo investigation, the effect of the act will be to require investigation of all applicants. Whether, as reported in the July 25th issue of *Newsweek*, the National Research Council will decline to administer the AEC fellowships under these restrictions has not yet been learned.

About People

Joseph B. Platt, associate professor of physics at the University of Rochester, has been given a two-year leave of absence to serve as chief of the Physics Branch of the Research Division of the Atomic Energy Commission in Washington.

Harry C. Dyme, chief chemist at the Foundation of Applied Research, San Antonio, Texas, has accepted a position as chief of the Nutrition Unit of the Aero Medical Laboratory at Wright-Patterson Air Force Base, Dayton, Ohio.

George G. Manov has left the Radioactivity Section of the National Bureau of Standards to become chief of the Advisory Field Service Branch of the Isotopes Division of the Atomic Energy Commission, Oak Ridge, Tennessee.

H. B. Hungerford has retired as head of the Department of Entomology of the University of Kansas. Dr. Hungerford will continue his teaching and research, both at the University of Kansas and, during summer months, at the University of Michigan Biological Station. He is replaced as chairman by **Charles D. Michener.**

Ruth Lofgren, assistant professor of bacteriology, University of Michigan, is guest investigator for the summer in the Microbiology Division, Scripps Institution of Oceanography, University of California, La Jolla, where she is studying the cytology of marine microorganisms.

Rudolph J. Pauly, director of the School of Pharmacy of the American University of Beirut, Lebanon, has been named assistant director of the Pharmaceutical Division of Sterling-Winthrop Research Institute, Rensselaer, New York.

Althea Revere, electron microscopy consultant, has been appointed associate professor of electron microscopy at the Graduate School of Stevens Institute of Technology, Hoboken, New Jersey.

N. T. Mattox has resigned as associate professor in zoology at Miami University, Oxford, Ohio, to accept a position as professor of biology at the College of Agriculture & Mechanic Arts of the University of Puerto Rico, Mayaguez, Puerto Rico. Dr. Mattox will organize and direct the founding of a marine biological research laboratory.

F. William Sunderman, head of the Department of Clinical Pathology at the Cleveland Clinic Foundation, has been appointed director of clinical research and head of the Department of Clinical Pathology at the University of Texas. Dr. Sunderman has also been appointed professor of experimental medicine and clinical pathology of the University of Texas Postgraduate School of Medicine.

Visitors to U. S.

Ch'ing-Sung Yü, *formerly of the* Nanking Observatory, is now conducting research as an associate on the staff of the High Altitude Observatory at Boulder, Colorado.

Recent visitors at the National Bureau of Standards included: the **Anglo-American Council on Productivity Simplified Practice Group, and Paul Vigoureux**, British Admiralty Research Laboratory, Teddington, England.

Grants and Awards

The Actonian Prize of one hundred guineas has been awarded by the Royal Institution of London to **Alexander Fleming** for his work in penicillin. The prize has been awarded every seventh year since its establishment in 1938. Dr. Fleming recently visited medical institutions throughout the U. S. and attended the dedication exercises of the Oklahoma Medical Reserve Foundation in Oklahoma City.

The Society of Chemical Industry awarded its biennial gold medal to Foster Dee Snell, chemical consultant of New York, at its Manchester, England meeting. Dr. Snell is the second American to receive the award.

The Royal Photographic Society of Great Britain has elected Loyd A. Jones, head of the Physics Department at Kodak Research Laboratories, Rochester, New York, an honorary fellow. The society had honored Dr. Jones twice before this year, by the award of both its Progress Medal and its Hurter and Driffield Medal.

Fellowships

The John and Mary R. Markle Foundation invites deans of accredited medical schools in the United States and Canada to make nominations for the third group of Scholars in Medical Science on or before *December 1*. Each school may nominate one candidate. He should have completed the usual fellowship training in some area of science related to medicine and should hold, or expect to hold, in the academic year 1950–51, a full-time faculty appointment on the staff of a medical school. Grants of $25,000 each, payable at the rate of $5,000 annually, will be made to the schools over a five-year period.

The number of Scholars to be appointed in 1950 has not yet been determined. Sixteen were chosen in 1948, and thirteen in 1949. A new booklet describing the plan, with suggestions for making application, is available on request from the Foundation, 14 Wall Street, New York 5, New York.

Industrial Laboratories

Schwarz Laboratories, Inc., 202 East 44th Street, New York 17, announces the availability of barium fructose-6-phosphate, dipotasium glucose-1-phosphate, and barium phosphoglyceric acid, three phosphorylated compounds used in studies of fermentation or enzyme reactions.

DuPont Company has begun construction in Philadelphia of a new $2,000,000 building, to be known as the Marshall Laboratory. It will be four stories high and will house laboratory facilities for research in paints, varnishes, enamels, synthetic resins, and other finishing materials.

A fused phosphate fertilizer, especially suitable for use on magnesium-deficient soils, is now being produced on a commercial scale by Manganese Products, Inc., at Seattle, Washington. The new fertilizer does not rot bags, requires no curing period, and is nonacid in its reaction.

Meetings and Elections

The United Nations Scientific Conference on the Conservation and Utilization of Resources will be held August 17–September 6 at Lake Success. Meetings will be held at 10:30 a.m. and 3:00 p.m. The full program follows: *August 17*, morning, plenary meeting, Introductory and Welcoming Addresses; afternoon, plenary meeting, The World Resources Situation; *August 18*, morning, plenary meeting, The World Resources Situation—A World Review of Critical Shortages; afternoon, plenary meeting, Using and Conserving Resources—Interdependence of Resources; *August 19*, morning, section meetings, New Techniques for Increasing Coal Production, The Appraisal of Water Resources, Forest Inventories, Methods of Soil Conservation, Storage and Preservation of Agricultural Products; afternoon, plenary meeting, Using and Conserving Resources—Soils and Forests; *August 22*, morning, section meetings, Underground Gasification of Coal, Water Supply and Pollution Problems, Protection of Forests, Soil Conservation—Organization and Evaluation of Programs, Changes in Abundance of Fish Populations; afternoon, plenary meeting, Using and Conserving Resources—Fuels; *August 23*, morning, section meetings, Mineral Supplies and Their Measurement, Coal Carbonization, Comprehensive River Basin Development—A Symposium, Forest Management, Soil Surveys—Research in Relation to S Conservation; afternoon, plenary meeting, Using and Conserving Resources—Metals and Minerals; *August 24*, morning, section meetings, Increasing Mineral Resources by Discovery, New Techniques for Increasing Coal Production, Drainage Basin Management, Aids to Farming, Management and Cultivation of Fresh Water Fish; afternoon, plenary meeting, Creatable Resources: The Development of New Resources by Applied Technology; *August 25*, morning, section meetings, Conservation in Manufacture, Techniques of Oil and Gas Discovery and Production, Protective Functions of the Forests, Improving Soil Productivity, Fisheries Statistics; afternoon, plenary meeting, Methods of Resource Appraisal; *August 26*, morning, section meetings, Inorganic Fertilizers and Conservation, New Techniques for Increasing Production of Oil and Gas, Water Control Structures, Administration of Forests, Game and Fur Conservation; afternoon, plenary meeting, The Adaptation of Resource Programs; *August 29*, morning, section meetings, Oil Chemistry, Flood Control and Navigation, Logging and Sawmill Techniques, Seeding and Restoration of Natural Grazing Lands, Management of Wildlife Resources; afternoon, plenary meeting, Assessing Resources in Relation to Industrialization Plans; *August 30*, morning, section meetings, Conservation and Mining and Milling, Utilization of Energy, Irrigation and Drainage, Protection of Crops and Grasslands, Livestock Breeding; afternoon, plenary meeting, Education for Conservation; *August 31*, morning, section meetings, The Outlook for Future Discovery—A Symposium, Utilization of Energy, Preservation and Chemical Utilization of Wood, Crop Policy and the Feeding of Livestock, Opportunities for the More Effective Use of New Agricultural Lands; afternoon, no meetings; *September 1*, morning, section meetings, Conservation by Corrosion Control, Utilization of Fuel, Hydro Power and Other Water Uses, Livestock Diseases and Tests, Research in the Conservation and Utilization of Marine Resources; afternoon, plenary meeting, Resource Techniques for Less Developed Countries; *September 2*, morning, section meetings, Conservation by Substitution, Plant Breeding, Condition of Grazing Lands, Developing Fishery Resources; afternoon, plenary meeting, Resource Techniques for Less Developed Countries—Labor and Public Health Techniques; *September 5*, morning, plenary meeting, The Integrated Development of River Basins—The Experience of the Tennessee Valley Authority; afternoon, plenary meeting, The Integrated Development of River Basins—A Symposium on Public Policy; *September 6*, morning, plenary meeting, Review of the Conference—A Symposium on Future Lines of Study and Directions for Progress; afternoon plenary meeting, Concluding Session.

A symposium on mineral nutrition of plants will be held at the University of Wisconsin on September 1–3. It will be followed on September 5–7 by a related **symposium on plant growth substances.**

The Tenth Annual Research Conference of the Institutum Divi Thomae and its affiliated units will be held in Cincinnati, September 6–9. Elton S. Cook, dean of research and head of the Division of Chemistry and Biochemistry, will act as general chairman. Reports will be presented on research in the fields of cancer, enzymes, growth, microbiology, and physics and physical chemistry.

The American Physiological Society will hold its regular fall meeting on September 14–17 at the Sheraton Bon Air Hotel and in the laboratories of the School of Medicine of the University of Georgia, Augusta.

A symposium on plasma proteins will be held in Chicago September 23–24 under the auspices of the University of Illinois College of Medicine and sponsorship of the Robert Gould Research Foundation. The foundation is at present devoting its funds primarily to support of scientific research in animal and human nutrition.

The Institute of Radio Engineers and the **Radio Manufacturers' Association** have appointed Donald G. Fink and John V. L. Hogan, fellows of the Institute of Radio Engineers, as chairman and vice chairman respectively of the Joint Technical Advisory Committee. Laurence G. Cumming, senior member of the Institute of Radio Engineers, was reappointed secretary of the committee. All three will serve for the term July 1, 1949–July 30, 1950.

The American Astronomical Society elected the following officers at its recent meeting in Ottawa: Alfred H. Joy, president; Dirk Brouwer, vice president; G. M. Clemence, G. P. Kuiper, and Andrew McKellar, councilors. J. J. Nassau, treasurer, and C. M. Huffer, secretary, were reelected.

The American Society for Engineering Education, at its annual convention at Rensselaer Polytechnic Institute, announced the election of the following new officers: president, Thorndike Saville, dean of engineering at New York University; vice presidents, B. J. Robertson, professor of mechanical engineering at the University of Minnesota; H. H. Armsby, specialist in engineering education, U. S. Office of Education; and F. E. Terman, dean of engineering at Stanford University.

An international symposium on morphogenesis was held under the auspices of the Centre National de La Recherche Scientifique in Strasbourg, France, July 4–12. The botanical and zoological part of the program had been organized by Drs. Gautheret (Paris) and Wolff (Strasbourg), respectively. The opening address on "The Future of Morphogenesis" was given by Paul Weiss (Chicago). Individual reports dealt with the following topics: vitamins in morphogenesis (Schopfer, Bern); estivation (David, Bordeaux); molecular problems of morphogenesis (Fauré-Frémiet, Paris); mechanisms of sea urchin development (Hoerstadius, Uppsala); rhizogenesis (Bouillenne, Liège); chemical regulation of plant organogenesis (Skoog, Wisconsin); correlations in plants (Champagnat, Strasbourg); regulation in amphibians (Dalcq, Brussels); development of amphibian lens (Woerdemann, Amsterdam); phyllotaxis (Plantefol, Paris); experimental morphogenesis in lower plants (Hurel, Paris); experimental embryology of *Tubifex* (Lehmann, Bern); experimental embryology of *Limnaea* (Raven, Utrecht); induction in avian development (Waddington, Edinburgh); regulation in avian development (Wolff, Strasbourg); tumor growth (White, Philadelphia); tissue culture and histogenesis (Gautheret, Paris); dedifferentiation in plants (Buvat, Paris); induction in annelid regeneration (Avel, Bordeaux); cell migration in planarian regeneration (Dubois, Strasbourg); development of flowers (Emberger, Montpellier). Participants report that the bilingual discussions brought ample proof of the need for close contact among botanists, zoologists, histologists, and biochemists in the analysis of morphogenesis. The harmonious spirit which prevailed during the conference augurs well for continued fruitful interchange among workers in this field on an international scale.

Deaths

Bernard E. Read, 62, acting director of the Henry Lester Institute in Shanghai, died in Shanghai on June 13. Dr. Read had taught and conducted research in China almost continuously since he went to Peiping Union Medical College in 1909 to head the Department of Pharmacology and Chemistry. He is the author of the six-volume text *Chinese materia medica*. Since 1932 Dr. Read had been in Shanghai and was interned there during the war. He later reestablished the institute, which had been pillaged of its equipment by the Japanese.

Roy Selden Cook, 58, professor of chemistry and head of the Department of Chemistry of Mary Washington College of the University of Virginia, died of a heart attack on June 18 at Fredericksburg, Virginia.

Charles Alfred Weatherby, 73, research associate of the Gray Herbarium of Harvard University, died June 21 at his home in Cambridge, Massachusetts. Mr. Weatherby had served as a member of the International Commission on the Nomenclature of Plants since 1935 and was recently appointed a vice-president of the Section on Nomenclature of the International Botanical Congress to be held in Stockholm in 1950.

William Frederick Prouty, 69, head of the Department of Geology and Geography at the University of North Carolina, died June 27 of a heart attack. Dr. Prouty had done extensive research on the origin of the bays and lake basins of the Carolinas.

Robert A. Blum, 28, research associate of the Yerkes Laboratories of Primate Biology, Orange Park, Florida, with rank of assistant professor at Yale University, died June 30.

Alexander MacLeod Fraser, 42, professor of pharmacology at Dalhousie University Medical School, Halifax, Nova Scotia, died on July 8. Dr. Fraser had been at Dalhousie less than a year and previously he had held the rank of of assistant professor at McGill University. During World War II he was engaged in the study of the physiology of high altitudes.

Wallace W. Atwood, 76, president emeritus of Clark University, Worcester, Massachusetts, died July 24. Dr. Atwood was professor of physiography at Harvard University from 1913 to 1920. He founded the Clark School of Geography and directed it until his retirement.

Plans have been announced for publication of the **Proceedings of the Seventh Pacific Science Congress**, held in New Zealand in February. It is expected that the printing will be completed by March, 1950. The six volumes—which comprise general proceedings; geology, geophysics and volcanology; meteorology and oceanography; zoology; botany and soil resources, agriculture and forestry; and anthropology—will be sold at a total estimated cost of $26.80, or as single volumes. The larger the initial order for printing, the lower the cost of the individual volumes will be. Early registration, therefore, with the Secretary-General, Pacific Science Congress, Box 27, Newmarket, Auckland S. E. 1, New Zealand, will contribute to lowering the cost. Complimentary copies of the proceedings will be available only to official members of the congress.

The Hall of Comparative Anatomy of the **American Museum of Natural History** has placed on exhibit a domestic donkey, last mounted specimen of the late S. Harmsted Chubb, who at the time of his death on May 6, 1949, was associate curator emeritus of comparative anatomy. Dr. Chubb had developed a realistic technique for mounting animals to show their characteristic action. The entire collection of his specimens, prepared during his forty-eight years at the Museum, will remain on permanent display there.

The Director of Translators and the Translations Pool (see *Science*, June 10, page 601) are now both under the sponsorship of the entire Special Libraries Association located at the Southwest Research Institute in San Antonio, Texas. The expanded services of the Translations Pool now include cards for 13,000 translations.

Studies in Air Hygiene, a report on the techniques for reducing airborne bacterial contamination through the use of filters, ventilating equipment, and chemical sprays, is now available. The report, published by the British Medical Research Council, discusses various instruments for sampling air; chemical, ultraviolet, heat, and filtration methods of air disinfection; field studies of air contamination in public places, homes, factories, and warships; and various air disinfection methods now available. The report may be obtained from British Information Services, 30 Rockefeller Plaza, New York 20, New York, at $2.35.

The Veterans Administration Hospital at Hines, Illinois is seeking a biochemist for its recently established neuropsychiatric laboratory. It is preferable that the applicant have a Ph.D. and experience in medical research. The starting salary for this position is $5,232 a year, with periodic increases up to a maximum of $6,235.

The Southern Association of Science and Industry has adopted as its official publication the new *Journal of Southern Research*. The journal contains a section reviewing technical works of Southern authors, a page listing patents issued to Southern inventors, and a news section devoted to the activities of Southern scientists.

Recently Received—

International Council of Scientific Unions, report of the Executive Committee for 1948. Printed at the University Press, Cambridge, England. Price 5s.

Nutrition Surveys: Their Techniques and Value. (NRC bull. 117). Published by the National Research Council, National Academy of Sciences, Wash. 25, D. C. Price $1.50.

Vertebrate Embryology by Richard M. Eakin. (University of California Syllabus Series No. 314). University of California Press, Berkeley and Los Angeles. $1.25.

"Murex Limited" (descriptive booklet outlining availability and industrial uses of Murex metallurgical and chemical products). Murex Ltd., Rainham, Essex, England.

Proceedings of the Auburn Conference on Statistics Applied to Research in the Social Sciences, Plant Sciences, and Animal Sciences, September 7–9, 1948. Statistical Laboratory, Alabama Polytechnic Institute, Auburn, Alabama.

Tracts for Computers: Random Normal Deviates, by Herman Wold. (No. XXV.) Cambridge Univ. Press, 51 Madison Avenue, New York 10, N. Y. $1.25.

Nuclear Instrument Handbook. (Reprinted from *Nucleonics.*) McGraw-Hill Publishing Co., New York 18, N. Y.

Cinchona Review edited by Albert Hemming. Cinchona Products Institute, Inc., New York, N. Y.

Right of Way Maintenance by Plant-Community Management by Frank E. Egler. Copies available from Conn. Tree Protective Association, Waterbury 84, Conn. at 30¢.

Proceedings of the Federal Inter-Agency Sedimentation Conference (held at the Bureau of Reclamation Laboratories, Denver, Colorado, May 6–8, 1947). Prepared for publication by the Bureau of Reclamation, U. S. Dept. of the Interior, Washington, D. C., from which copies are available for limited distribution.

Electronique Magnetonique et Radiation by Maurice Ducharme. Montreal Radio College, Montreal, Canada.

Conference on Metabolic Aspects of Convalescence: (1) Transactions of the Sixteenth Meeting, New York, October 27–28, 1947, (2) Transactions of the Seventeenth Meeting, New York, March 29–30, 1948. Available from Josiah Macy, Jr. Foundation, New York 21, N. Y. at $3.00 and $4.00 respectively.

Make Plans for—

Conference on Low Temperature Calorimetry, September 10, Massachusetts Institute of Technology, Cambridge.

American Chemical Society, 116th national meeting, September 18–23, Atlantic City, New Jersey.

Illuminating Engineering Society, national technical conference, September 19–23, French Lick, Indiana.

Civil Liberties of Scientists

On December 30, 1947 the AAAS Council passed a resolution instructing the President of the Association to appoint a Special Committee on Civil Liberties for Scientists. Maurice B. Visscher was named chairman, and with Philip Bard, Robert E. Cushman, Richard L. Meier, and James R. Newmen as members, and Walter Gellhorn as consultant, the Committee completed its investigations and submitted a 77-page report of findings and recommendations in December 1948. The full text was referred to the Council, which voted by an overwhelming majority to publicize the findings, and it is planned ultimately to make the complete report available at cost to those who want access to it. Announcement will be made in Science *when Maurice B. Visscher and E. C. Stakman have concluded editorial revisions and the report is ready for distribution. Meanwhile, by vote of the Executive Committee at its meeting July 7, the conclusions and recommendations are published herewith.*

THERE IS AT PRESENT a tendency in public thinking to relate scientific activity almost wholly to military activity, exposing scientists more than most occupational groups to sustained and stringent limitations upon their professional freedom. Fearful lest these limitations exceed justifiable bounds, jeopardize the national welfare, and infringe the rights of scientists, the American Association for the Advancement of Science, in December 1947, created a Special Committee on the Civil Liberties of Scientists.

The present report embodies its conclusions and recommendations with respect to three main areas:

1. Restrictions on research and scientific information;
2. Measures to assure the personal reliability of scientists having access to confidential data;
3. Inquiries relating to the "loyalty" of scientific workers in federal employment.

CONCLUSIONS

I

Secrecy is damaging to both science and democracy. In both, progress and the detection of error depend upon open discussion and free interchange of ideas among widely divergent and widely separated groups. Yet today, in the United States, we have within the body of science large regions of secrecy. We endorse the statement of the President's Scientific Research Board, which in its 1947 Report on Science and Public Policy said: "Strict military security in the narrow sense is not entirely consistent with the broader requirements of national security. To be secure as a Nation we must maintain a climate conducive to the full flowering of free inquiry. However important secrecy about military weapons may be, the fundamental discoveries of researchers must circulate freely to have full beneficial effect. . . . Security regulations, therefore, should be applied only when strictly necessary and then limited to specific instruments, machines or processes. They should not attempt to cover basic principles of fundamental knowledge."

II

No matter how the area of secrecy may be delimited, there will undoubtedly remain some matters of scientific cognizance which should be kept confidential. So long as national policy dictates that secrecy be observed, the reliability of persons to whom these matters are entrusted must be assured; hence inquiries into the character and attitudes of these persons are warranted.

If national as well as individual interests are to be protected, however, improvements must be achieved in the policies and procedures of our present security clearance programs as they affect scientists who will be entrusted with classified information.

The Atomic Energy Commission and the National Military Establishment are the chief agencies concerned with the trustworthiness of scientists who have access to "restricted" or "classified" data. Neither of these agencies furnishes the affected scientist any statement of the reasoning underlying a conclusion which is adverse to him; neither one sets forth charges in a precisely formulated fashion; neither one requires that testimony used against an individual be made known to him, or that even casual and nonofficial informants be identified and produced for examination; neither one provides for the making of specific findings of fact; neither one undertakes to record and publish its opinions in a way which makes possible any public understanding or analysis of the determinations made.

In some respects the procedures of the Atomic Energy Commission are more fully elaborated than those of the National Military Establishment, though the military clearance of the latter may affect literally millions of employees of private industry engaged in the planning or production of articles for military use. A military determination that clearance should not be granted a civilian scientist is subject to appeal to the Industrial Employment Review Board (IERB), composed of Army, Navy, and Air Force officers. Procedings of the IERB are themselves "classified," which means that even the immediately affected employee is forbidden to discuss them, keep notes about the handling of his own case, or possess a copy of the record of the hearing. Despite the fact that its decisions have a drastically important impact upon the lives and careers of civilians entirely outside the public service, the tribunal is exclusively military in its composition and there is no opportunity for review of its judgments by an appellate body differently constituted. Such subjection of the destinies of civilians to military tribunals is contrary to national tradition. Quite apart from procedural inadequacies, the present organization for deciding security clearance cases is open to basic criticism.

The Atomic Energy Commission has recently manifested a tendency to require security clearance not only for those scientists who themselves have access to restricted data, but also for their fellow scientists with whom they may have personal contact. This is graver in its implications than even the serious procedural and administrative imperfections already noted. At Brookhaven National Laboratory, for example, where only perhaps one-tenth of the scientific personnel works within the area of secrecy, all scientists must be cleared as a condition of employment. This apparently reflects a yielding to uninformed or sensationalist legislators and others who tend to exaggerate the problem of "keeping our atomic secrets." The effect of the excessive precautions is to discourage participation in important research activities closely linked to the nation's well-being. Scientists are increasingly reluctant to commit their personal and professional reputations to those who have brought frivolous charges against respected colleagues. Moreover, the delays and expense often involved in obtaining security clearance deter qualified persons from entering the atomic energy program.

So far as disclosures of evidence reveal, the problem of faithless scientific personnel in this country appears to be markedly less grave than the public has been led to suppose. Moreover, informed scientists are in broad agreement that restricted data cannot be readily transmitted to unauthorized persons. In the circumstances which exist rather than those which are fancied to exist, the stringent application of personnel security clearance should be limited to smaller numbers of scientists rather than extended to ever larger groups. If nothing is done to reverse the present trend to require security clearance of scientists who do not have or desire to have access to restricted data, it is likely that many of the most penetrating and original scientific minds will be turned to pursuits unrelated to further development of the atomic energy program. Work in that field will be shunned by men of ability and pride if they are constantly treated as objects of suspicion and possible calumny.

III

Executive Order No. 9835 provides that no person shall be employed in a federal post if he is believed to be disloyal to the government of the United States. This Loyalty Order does not supplant existing provisions for summary removal of employees on security grounds. Entirely without reference to security considerations, the Order seeks to assure "complete and unswerving loyalty to the United States" on the part of all those who are in its service.

No one doubts the importance of faithful discharge of duty by public officials. No one questions the propriety of the government's demanding that its employees be loyal to their jobs and to the democratic institutions they serve. The Loyalty Order is, however, basically objectionable because it seeks to determine the employee's loyalty by inquiring into his supposed thoughts and attitudes, which are established in large part by imputing to him the beliefs of his associates.

If the Loyalty Order is to be retained, a drastic revision is essential. Instead of focusing on an employee's associations, it should focus on his behavior in overt acts. Legislation already on the statute books amply protects the federal service against retention of employees who advocate overthrow of the government.

Insofar as the Loyalty Order purports to deal with such matters as espionage, sabotage, and disregard of instructions, it is wholly superfluous, since conduct of that character is not only criminal but is also fully subject to administrative disciplinary action under existing law and regulations. The failure to confine the Loyalty Order to matters of objective proof has engendered a feeling of insecurity in public employment and may be expected to lessen the vigorous intellectual independence which is a prime condition of sound scientific work as it is of an imaginative civil service. "Experimentation there may be in many things of deep concern," Judge Cardozo once wrote, "but not in setting boundaries to thought, for thought freely communicated is the indispensable condition of intelligent experimentation, the one test of its validity." Unless there is elimination of the Order's present emphasis on attitude rather than conduct, the nation will suffer heavily from the present loyalty program.

Even if the Loyalty Order were to be continued without revision of its underlying philosophy, important changes in administrative methods are urgently needed. The present loyalty boards discharge simultaneously the functions of advocacy and adjudication. The content of the charges they issue and the conduct of the proceedings over which they preside do not assure that the facts and their implications will be fully explored. The organizations with which an employee may be identified are finally and conclusively characterized by the Attorney General without either the employee's or the organization's having any opportunity whatsoever to establish that the Attorney General was not fully informed. These and other procedural deficiencies can be corrected readily. So long as they remain, they accentuate the possibility of error in the loyalty program.

The fundamental shortcomings in the Loyalty Order, however, are not procedural. Rather, they are to be found in the very conceptions which the Order expresses. Refinement of administrative methods and gentility of official behavior are important, to be sure. But they are not basic. Until the Loyalty Order deals with the way employees act, rather than with the way they supposedly think, we shall inhibit the freedom and encourage the insecurity of our public servants. The cost will in the end be borne not by the employees who are deprived of their normal freedom to believe and behave as they wish within the limits law has set. It will be borne by the nation as a whole.

As President Truman recently asserted, "Continuous research by our best scientists is the key to American leadership and true national security. This work may be made impossible by the creation of an atmosphere in which no man feels safe against the public airing of unfounded rumors, gossip, and vilification."

Challenge to Social Science

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THE INDUSTRIAL REVOLUTION is a term that the elder Toynbee used to describe the historical shift in the basis of human culture from agrarian to industrial. The student generally learns a few names of men associated with this period—Watt, Whitney, Hargreaves—and their respective inventions, but only rarely does he discern their relationship to the problems before which the world now trembles. The fact is, however, that the revolution is moving on more rapidly during his lifetime than ever before, and engineering, chemistry, electronics, aviation, biology, and many other sciences are contributing to it.

The intellectual equipment for making this change was perfected by the labors of a host of men, scattered over a period of two thousand years. The scientific method that they applied to the material world has loosed a torrent of discoveries.

Many results of these discoveries were beneficial and brought higher standards of living. Mass production could succeed only on a base of mass power to consume, more leisure, and the broadened knowledge and experience that stemmed from mass communication and transportation.

One profound change has been the shift from independence to interdependence. When the simple life prevailed, contacts were individual, relationships were uncomplicated and characterized by a high degree of self-sufficiency and independence. Today we know the paralysis that can occur with the breakdown of any of the numerous lines of supply within a nation.

Nations are as interdependent as their citizens. Vitally needed products must be exchanged throughout the world, and an economic depression in any leading nation means that all others will be similarly affected. Any science or organized knowledge is the joint product of men all over the world.

This interdependence has led to an extension of moral values from the personal and community level to the national and international level. Individual morality becomes inadequate when it is possible for a person to refrain from stealing from his neighbor, lying to him, cheating or killing him and yet advocate national or international policies that lead to mass destruction of peoples. The most humane and kindly individuals may be greatly disturbed at the suffering of one child but innocently contribute to wholesale suffering and death thousands of miles away.

Mass civilization has impersonalized relationships between men. When one killed with the sword, he saw his antagonist fall, saw his blood, and heard his dying gasps. To the killer this was real. In modern war a plane flies over a city, a man in the plane presses a button, and ten or ten thousand people may die. The killer himself is only the final link in a long, mechanized, and impersonal chain of events, and even he does not witness the deaths of the people he kills. Successful war now means total war, and the civilian comes to suffer more than the soldier.

Being moral involves, therefore, much greater knowledge of national and world events. It makes greater demands upon the intelligence of people who have become citizens of the world whether they happen to like it or not. Good intentions are less and less adequate to the situation.

Natural science has become "dehumanized," as James Harvey Robinson (*7*) so clearly described. Its adherents have in large measure become so specialized that they give little consideration to the effects of their discoveries on the population or how their techniques and knowledge might help solve problems. In this unawareness they have been burrowing into nature and throwing up great heaps of specialized information and expending little effort on organizing and utilizing it to best social advantage. As Robinson said a quarter century ago:

> We are forced to ask ourselves whether it is safe, since our life has come to be so profoundly affected by a dependence on scientific knowledge to permit the great mass of mankind and their leaders and teachers to continue to operate on the basis of presuppositions and prejudices which owe their respectability and currency to their great age and uncritical character and which fail to correspond with real things and actual operations as they are coming to be understood. Even the more magnificent scientific discoveries, especially those of recent years, have not penetrated into our general education and are entirely disregarded in most discussions of social problems.

This has led to what a symposium of British scientists called "The Frustration of Science (*2*)." The original aims and basic intentions are clear enough. The physicist Harold Urey (*8*) says:

> I believe I speak for the vast majority of all scientific men. Our object is not to make jobs and dividends. These are a means to an end, merely incidental. We wish to abolish drudgery, discomfort and want from the lives of men and bring them pleasure, comfort, leisure and beauty. Often we are thwarted but in the end we will succeed.

One sees on every hand, however, that Bacon's gunpowder, for example, can be used either for food or for homicide; Nobel's dynamite, as he discovered, for engineering or for bombs; the automobile and ship for the spread of culture or for tanks and destroyers; the Wrights' airplane to bind the world more closely together or blow it to pieces; organic chemicals for life-saving drugs or incredibly potent poisons; knowledge of microorganisms for the conquest of disease or bacteriological warfare; and radioactivity for medicine and power or for the obliteration of cities and nations. How are we to determine what the alternative will be? We cannot follow our present rate of destruction very far and survive.

Men have begun to ask themselves, "What can we do to solve the frightening difficulties into which our distorted ingenuity has led us?" Since the rise of biology, psychology, sociology, and anthropology during the last century we have been compelled to recognize that it is possible to apply scientific procedures to the problem of comprehending, predicting, and intelligently controlling human behavior. The old stereotype of science as frozen content, limited to a small number of fields, persists, however, despite the fact that its history shows, in the words of Karl Pearson, that it "is not peculiar to a certain subject matter."

More specifically, a series of writers have maintained with increasing effectiveness that scientific methods are applicable to social problems—during the last century John Stuart Mill, Auguste Comte, and Karl Pearson; more recently Graham Wallas, James Harvey Robinson, Harry Elmer Barnes, and John Dewey. The last five years have brought the publication of Lundberg's *Can science save us?* (*3*); Williams' *Human frontier* (*9*), expressing the approach of the biochemist; *Human nature and enduring peace* (*6*), the psychological analysis of the war, edited by Gardner Murphy; and Stuart Chase's *Proper study of mankind* (*1*), giving the coordinated approach to man of many social scientists. We should not omit Lynd's admirable *Knowledge for what?* (*4*) and Mayo's *The social problems of an industrial civilization* (*5*).

Organizations, too, have been active—among them Yale University's Institute of Human Relations and the Society for the Psychological Study of Social Issues. Several foundations for humanics and scientific industrial relations are in process of development throughout the country. All these efforts point in the direction of a new synthesis of information from many fields, information which is relevant to the solution of modern problems.

The American sociologist Ogburn devised the term "cultural lag" to describe the failure of the social phase of culture to keep up with the physical. It is now a platitude to say that scientific methodology must be applied to human problems if we wish to reduce this ominous lag. What will this mean in the development and growth of the social sciences?

Social science is a flexible term, embracing history, economics, political science, and sometimes education, sociology, and psychology. Some institutions of higher learning are beginning to classify psychology with the biological sciences. Only in sociology and psychology have scientific methods been practiced systematically. If the social sciences are to grow—as they must if man is to survive—certain improvements are necessary.

(1) The success of the natural sciences can be credited very largely to the constant reconstruction of ideas. Proponents of the *status quo* are the villains of their history, when known at all. The experience of these sciences has been that there is no progress unless someone is continually finding fault with things. Only in this way can old concepts be strengthened and new ones discovered. Fending off criticism weakens a cause by denying it the opportunity to grow and to keep in close contact with a changing world.

It is not easy to invite criticism even in the physical sciences, where most data are inanimate objects. In the social sciences, where data are the intangible thoughts and emotions of people, this difficulty becomes the primary concern. What is its source?

In social inquiry we tend to identify our own ego with various concepts which we accept, and to regard criticism of ideas as destructive criticism of the personality holding them—as it too frequently is. It is tragic to see reputable social scientists falling victim to this tendency.

The solution has already been found, not only by physical science but by many ordinary people who have achieved the capacity to dissociate judgment of the man from the ideas held. There is need for social criticism if it is offered in a constructive spirit. Everyone should seek it eagerly and be able to profit from it, gaining the advantage of a great positive force. We agree that everyone is fallible. Science has shown how this fallibility may be combated most effectively in a way that preserves mutual respect and offers the thrilling experience that accompanies a joint search for truth.

(2) One of the primary objectives of criticism is stimulation of new ideas. Social science has heretofore looked too much to the past for answers to its problems. This does not mean that there is no value in the past. It does mean that the complex problems of an interdependent and technological universe are unique in human history and that unique solutions must be devised.

We venerate leaders of the past precisely because they were courageous and farsighted enough to challenge old concepts with new ones for a new age. The fact that a problem exists is proof that old concepts have proven inadequate to the situation. The universe is dynamic and change is eternal. Human institutions and problems are the most rapidly evolving segments of it. Refusal to recognize and guide this change will merely insure greater confusion.

If history demonstrates anything it is that a frigid reception is invariably accorded new social proposals. The social sciences stand now in their development where the physical sciences stood in 1600 and its innovators may expect a similar fate. Will we again require 400 years to achieve our goal?

It is interesting to compare attitudes in the physical and the social sciences. We take pride in the newest and most modern gadget or technique. We are disturbed if the doctor evidences the slightest suggestion that he is "behind the times," since this may mean needless suffering. But in social matters we are equally proud of beliefs which were current when diseases were treated by boring holes in the head. Barnes puts it picturesquely when he says, "The only place we prize antiques more than in our living rooms is under our hats."

It is true, as many maintain, that we should show a healthy skepticism toward new propositions until they have been proven. It is interesting to note, however, that those who advocate such experimental testing of new concepts frequently do nothing to assist it and in fact may do a great deal to prevent it. We must devise ways to keep the intellectual concrete from setting too early and too hard.

(3) In the natural sciences we have learned the tremendous value of subsidizing the search for objective truth. This means criticism and new ideas against which there is determined opposition. Why?

Change in human institutions is thwarted by several forces. First is the immense power of custom; one discovers early in life that things are done according to a set pattern and that fundamental deviation from it will surely be accompanied by ridicule and social disfavor. Closely related is that intellectual inertia which manifests fear of anything new. This fear cannot be inborn, since the same people will show no such fear of new physical concepts or devices once they have become habituated to the idea of change. There is also a lack of the information necessary for enlightened action. Finally there is special interest in the *status quo*, which is a tremendous force.

How many agencies can the reader name that subsidize the analysis and reconstruction of human institutions without respect to the results? Yet the value of objectivity has been demonstrated in the physical sciences. Newton had no patents on gravitation, nor did Pasteur and Koch have an investment to protect when the virus was discovered to be another cause of disease besides the bacterium.

The NAM will sponsor an investigation whose conclusion has already been established, and the CIO will spend money to prove the opposite. People in such organizations do not invite even the most helpful criticism. Lobbies, pressure groups, and influential business interests represent highly effective instruments for thwarting scientific attack on problems.

(4) Before any reliable information can be communicated we must be sure that our words symbolize something that really exists and furthermore that they convey the same conception to everyone who is influenced by them. This is the principal aim of semantics and propaganda analysis, which, together with logic and statistics, are the indispensable tools of the social scientist.

Although the original purpose of language was to communicate accurate information, its present misuse contributes to prejudices, destructive criticism, and frustration of new concepts. History uncritically preserves in its texts the most emotionalized and misleading language imaginable. Political economy and political science abound with sacred cows and verbal demons. Perhaps no language reform could succeed in making a true science of social problems but there is no doubt that decided improvement can be made.

In the natural sciences, use of Greek and Latin has provided a symbolism to avoid the changed meanings and affective connotations of popular usage. It is too much to expect that such a symbolism could be applied extensively to social problems. The reason is not far to seek. Those who support government by the majority must recognize that this majority is not likely to adopt such a mode of expression.

Fortunately, however, we do not have to resign ourselves to the nightmares of distorted meaning which the semanticists are able to select as examples of our everyday speech. The average person can grasp a few simple rules that will avoid the present confusion.

Let us illustrate one difficulty by returning to the word *criticism*. It denotes constructive analysis and yet hearing the word evokes a mental picture of an ill-adjusted, complaining egotist because these connotations have been built up through popular use. The semanticist would probably advise the use of another word, such as reconstruction. In a moment we will consider the operational approach to meaning.

(5) Social science tends to get lost in a forest of particulars. Facts, although they are indispensable, can never tell us anything by themselves. Conclusions must be drawn from them. Disciples of the monographic school of historians of a half-century ago supposed that they could found a true science of history upon a massive accumulation of facts on the subject. But history as the record of human behavior can be understood and interpreted successfully only when there are some clearly defined standards for evaluation and objective techniques for processing data. Only in this way can the historian capture even partially the forces shaping events as they occur.

A few fundamental principles of human behavior are greatly needed for use in organizing its data. Institutions fail because they violate these principles—governments fall, parties go out of power, economic and social systems disintegrate. History lacks objective standards for evaluating its immense accounts. Facts are all things to all men and can be made to point in any direction.

Without a guide to their meaning, facts alone, however compendious, are almost useless. Historians select from a stockpile of past events (which make their own appear trivial) those showing what they wish to show. Thus we see the tremendous scholarship of Toynbee and Gibbon and of von Ranke and Robinson producing opposite theories, and the only basis for selection we have is our own prejudice and desire.

We have not yet realized the full significance of the elementary principle that there are causes for social phenomena. If we applied that principle we would renounce such attitudes as blame and condemnation of sin. These attitudes lead us away from an attack on causes and therefore away from cure and prevention of human ills. No physicist would kick his apparatus because it didn't work right.

What should we think of a medical science that concerned itself primarily with recording one-tenth degree fluctuations in the patient's fever, as economists chart their business cycles? What should we think of the physician who treated smallpox by covering up sores with flesh-colored cream? Yet this is what we are doing when we institute home relief.

Recognizing the principle of cause would mean also abandoning the prevalent attempt to interpret social phenomena in terms of what is "right" or what "ought to be." The scientific approach does not begin with ideas in mind about what nature "ought to do," but recognizes that fundamental laws operate to cause events to take place in the observed way. We are compelled to discover these basic realities and adjust our own acts accordingly so as to derive the maximum advantage and control of nature.

Science is pragmatic. Much scientific knowledge is based on what works, even when we lack exact information on how it works. But those who think they can get by with violating laws of human behavior, denying basic human needs, because "it works," will soon find out that it does not work for long and that the cost of such short range pragmatism is very high.

(6) After investigation and criticism have disclosed tentative conclusions, expressed in accurate language—after the hypothesis has been established, what then?

What an idea really means to people, the true measure of its relative significance, can be discovered only by observing how their actions are affected.[1] This truth has found many expressions from "by their fruits ye shall known them" in the Sermon on the Mount to the dictum of the physicist Bridgman that answers to questions can be realized only in terms of actual operations. If the difference between philosophy and science could be defined the distinction would probably have to be made on this action basis.

What we can get people to say and what we can get them to do are often very different things. Most legislators denounce lobbies and trusts. In view of their agreement their lack of action might at first be surprising. A federal judge recently spoke of the trust question as "a problem for Congress." But the yearly appropriation Congress makes for such prosecutions is less than what *one* corporation has spent on *one* antitrust suit. A bill on lobbies was recently introduced in the Senate but was stalled in subcommittee and has not even been able to reach the debating stage on the floor. There might be legitimate room for doubt about the most effective approach but there is no excuse for not undertaking some action that might produce results, even if several methods had to be tried.

The most frequent objection to the application of scientific methods to human problems is based on the belief that knowledge is certain and permanent in the natural sciences, whereas behavior difficulties are so complex that definite conclusions cannot be reached. People who hold this paralyzing belief do not realize first how much change is constantly occurring in the principles of physical science and second, how successful we have already been in the analysis, prediction, and control of behavior. Our analysis is based upon the observed reality of fundamental motives which constantly direct our actions. Our real problem is to find what types of institutions can be most successful in terms of these realities.

The do-nothing attitude in respect to the social sciences often falls back on the "two sides to every question" stereotype. There may be any given number of hypotheses worthy of consideration when little evidence is available. As the evidence accumulates the number of tenable hypotheses decreases. It soon becomes clear which one is the most probable. We cannot avoid acting on some assumption. It is the constant purpose of science to make assumptions explicit and to relate them to facts as closely as possible.

Apathy about human affairs is tragic, because the reasons for it are perfectly apparent and remediable. Most people believe that modern problems are insoluble, at least for them. When they turn to social science they are crushed by the weight of details and bewildered by the indefiniteness and contradiction of authorities. The physical sciences, on the other hand, are forbidding because they are so technical and abstruse that the average man hasn't a chance. Fortunately, however, it is not necessary to understand the physics of the chain reaction in order to grasp the real social significance of atomic energy.

If the ordinary person had to become an expert in social technicalities to fulfill his duties as a citizen we might well forget all about having the majority exercise control over public affairs. But we do not all have to be experts if we get down to working agreement on some basic principles and encourage the critical ability to apply them. Only then can we look forward to a world made safe for human life.

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TECHNICAL PAPERS

Hemagglutinating Behavior of Mouse and Egg-adapted Type A (PR8) Influenza Virus[1]

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Influenza virus undergoes a change when introduced into the mouse following either primary isolation or adaptation in the chick embryo (*1*, p. 357, and *3*). Both Hirst (*1*, p. 357) and Wang (*3*) showed that the egg-adapted virus multiplies readily in the lungs of mice without producing either the clinical disease or histological changes. Death or pulmonary lesions will occur after the egg-adapted virus has had several passages through mice.

The present study indicates that mouse-adapted influenza virus undergoes a change when the virus is returned to the egg; although this change appears to be easier than the egg-to-mouse adaptation.

The PR8 strain of influenza virus A which was employed in these experiments has been maintained in the laboratory by allantoic passages through fertile eggs. Its virulence for mice had decreased so that the mean lethal dose which kills 50% of the animals (LD_{50}) per 0.05 ml intranasally was 10^{-2}. After 25 mouse passages, this mouse-adapted strain possessed an LD_{50} of 10^{-4}. These passages were performed by harvesting lungs 3–4 days following inoculation, making a 10% suspension in buffered saline by homogenizing in a Waring blender, and reinoculating into 3–4-week-old mice.

Ten-to-eleven-day-old embryos were inoculated into the allantoic sac with 0.2 ml of a 10^{-3} dilution of mouse-adapted or original egg virus. At 2-hr intervals, 5–10 eggs of each group were removed from the incubator and placed in the refrigerator. This was continued for every 2 hr up to 24 hr.

Allantoic fluid was harvested in the usual manner at each 2-hr period and titrated in the hemagglutination test by the pattern method of Salk (*2*) with human type O erythrocytes.

The data recorded in Fig. 1 are the results of a typical experiment with the 27th passage mouse strain. The egg virus was from a pool of allantoic fluid.

It was demonstrated that the egg strain produced hemagglutination at least 4 hr earlier than the mouse strain. Similar results were obtained with material from other mouse passages and other allantoic fluid pools. The earliest that hemagglutination was produced by the egg strain was 12 hr, while for the mouse strain it was 18 hr after inoculation. These were obtained in simultaneous titrations, using material from the 31st mouse passage; the egg material was from an allantoic pool not previously titrated. There was some variation in end points but when tested after 24 hr incubation, they were essentially the same for both strains. One egg passage sufficed to make the mouse strain indistinguishable from the original egg strain in hemagglutinating capacity.

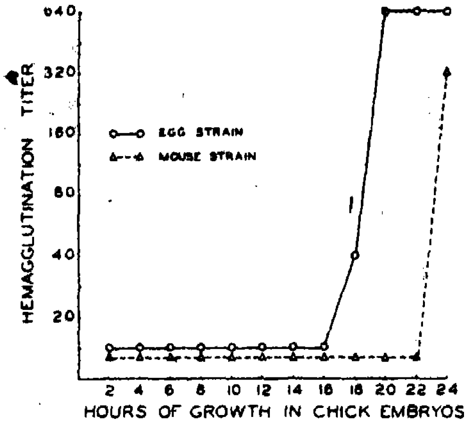

FIG. 1. Hemagglutinating ability (type O red blood cells) of mouse-adapted and original egg strain in the chick embryo. Type A (PR8) influenza virus employed.

When the mouse-adapted PR8 strain was cultivated in the mouse lung and hemagglutinating ability determined at 2-hr intervals, the results were essentially similar to those obtained by Wang (*3*). Perceptible hemagglutination with mouse lung virus was obtained within 6–8 hr after intranasal inoculation. As also observed by Wang, infection of chick embryos occurred more rapidly than hemagglutination.

The data reported here substantiate the observations of others (*1*, p. 357, and *3*) that changes occur in the virus particle which is adapted to a different host. Whereas the results obtained by these workers indicate that there is a marked change in the virus when adapted to the mouse from the egg, little information is available concerning the reversal of this adaptative procedure. It appears, as Hirst suggests (*1*, p. 367), that adaptation to the egg is "a less drastic procedure than mouse adaptation."

Our data appear to agree with Hirst's findings that egg-adapted strains from a given epidemic do not differ significantly (*1*, p. 367). One may postulate, then, that the virus particle in adapting itself to a host alters itself to take advantage of the new host's metabolic systems. Thus, when the virus is introduced into a new host with a slightly different metabolic pattern, a probable rearrangement of the virus molecule occurs.

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Cytological Evidence Opposing the Theory of Brachymeiosis in the Ascomycetes

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Recently a collection of the discomycete, *Patella melaloma*, was obtained by the writer from burnt-over ground in this area. The fungus has been maintained in culture, where it readily produces its fruiting structures or apothecia. The species is of particular interest because it is one of several discomycetes studied by Gwynne-Vaughan (*1*), the most outstanding contemporary proponent of the theory of double fertilization (two nuclear fusions) and brachymeiosis (two reductional divisions) in the ascomycetes.

Probably the majority of geneticists and most cytologists working on the ascomycetes have doubted for some time that these two processes occur. Thus far, however, no convincing evidence has been presented either to prove or to disprove the theory for those species in which these phenomena are said to exist. Most of the species of ascomycetes in which double fertilization and brachymeiosis have been reported to occur have proved unfavorable for genetical study. In those heterothallic species which might be used for genetical study such difficulties are experienced as inability to obtain a satisfactory percentage of ascospore germinations, or failure of the ascospores to occur in an orderly sequence in the ascus, or failure of the fungus to fruit well in culture. All the cytological evidence bearing on this subject has thus far been in the form of drawings and descriptions of sectioned material stained with the use of techniques which are frequently inadequate for revealing the chromosome numbers of the nuclei at various phases in the life cycle.

With the use of the propiono-carmine staining technique, recently employed with excellent results by Wheeler *et al.* (*2*) in a cytological study of ascus development in *Glomerella*, the writer has been able to observe the three successive nuclear divisions in the ascus of *Patella melaloma* and to determine with certainty the number of chromosomes present during each division. One of the most important features of this technique is that it leaves the spindle fibers unstained and that the chromosomes stand out clearly in the nuclear vacuole. Photographs demonstrating the numbers of chromosomes in all three divisions in the ascus have been obtained and will be included in a paper to be published later.

Gwynne-Vaughan (*1*), in her study of this species, reported that the nuclei fused in pairs in the ascogonium to produce diploid nuclei. These diploid nuclei were believed to pair among themselves, migrate into the ascogenous hyphae, and finally fuse in pairs in the young asci. Thus each ascus was believed to contain a tetraploid nucleus. She stated that the tetraploid number of 8 chromosomes (4 pairs) was observed at metaphase of the first division in the ascus. These chromosomes were believed to pass in groups of 4 (the diploid number) to opposite poles of the spindle. In this way the first reductional division was completed. Each daughter nucleus was then observed to divide mitotically, 4 chromosomes passing to opposite spindle poles. Then in the third division, each of the 4 nuclei was believed to undergo a second reductional division with 2 chromosomes (the haploid number) passing to opposite spindle poles. Therefore each of the 8 ascospores was supposed to receive a nucleus with only 2 chromosomes.

The writer is able to confirm Gwynne-Vaughan's report that there are 4 pairs of chromosomes present at the beginning of the first nuclear division in the ascus, and that a complement of 4 passes to each pole as the division is completed. In the second division also, 4 chromosomes appear and divide, a complement of 4 passing into each daughter nucleus. But the third division, instead of being reductional as Gwynne-Vaughan described it, is similar to the second division, and 4 chromosomes, rather than 2, pass into the daughter nuclei. The 8 ascospore nuclei, therefore, contain 4 chromosomes each. It is obvious from this brief description that the chromosome number is reduced only in the first division. The diploid number of chromosomes is 8 and the haploid number is 4. The third division is nonreductional. It is therefore obvious that brachymeiosis does not occur in this fungus. It is equally obvious that there can be no double fertilization in the life cycle.

The writer intends to extend these observations to other species in which double fertilization and brachymeiosis have been reported. The propiono-carmine technique is recommended as an efficient method for obtaining chromosome counts in the ascomycetes.

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Inability of Thymine and Adenine to Substitute for Pteroylglutamic Acid in the Folic Acid-deficient Rat

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Although it has long been recognized that thymine can replace folic acid for growth of microorganisms (*3*), it has not been emphasized sufficiently that both thymine and purine bases are required for this purpose (*5, 6*). If an analogous situation exists in animals, it might be expected that thymine alone would be ineffective in replacing folic acid in a synthetic type of diet which does not supply purine bases, and this has indeed been shown true for both the rat and the chick (*1, 3, 4*). Experi-

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[1] The authors are greatly indebted to Dr. E. E. Snell of the University of Wisconsin for his helpful suggestions and criticism. They also wish to thank Alice M. Bergdahl for assistance in obtaining the hematologic data.

ments wholly analogous to the bacterial growth tests, i.e., in which a dietary source of both thymine and purine bases has been supplied in an effort to duplicate the growth and hematopoietic effects of folic acid, have not been previously reported. We have therefore extended our previous work to include such experiments.

Twenty-eight-day-old littermate rats and the basal diet containing 2% succinyl sulfathiazole as previously described (*4*) were used in each of the two experiments reported here. In experiment 1, using ten rats, the supplements were incorporated in the basal diet and fed ad lib. for a 5-week preventive period. In experiment 2 the supplements were fed daily for a 2-week curative period after a depletion of 5 weeks. The results are shown in Tables 1 and 2.

The data seem conclusive in demonstrating that neither thymine combined with adenine sulfate or adenosine, as in experiment 1, nor thymine and adenine supplied as thymus nucleic acid, as in experiment 2, show physiological activity in replacing folic acid for growth and hematopoiesis in the rat fed a purified diet containing Sulfasuxidine (succinyl sulfathiazole). These data are pertinent in discerning the possible mode of action of pteroylglutamic acid in animal metabolism, since it has been postulated by Rogers and Shive (*5*) and Spies *et al.* (*2, 7*) that folic acid operates in the enzymatic synthesis of purines and pyrimidines.

TABLE 1

EXPERIMENT 1. EFFECT ON RATS OF THYMINE, ADENINE, AND ADENOSINE AS SUPPLEMENTS TO A PURIFIED DIET CONTAINING 2% SUCCINYL SULFATHIAZOLE (FOLIC ACID-DEFICIENT DIET)

Supplements	Initial weight in g of 28-day-old rats	Final weight in g of 63-day-old rats	Weight gain in g	R.B.C. (cells/mm³ × 10⁻⁶)	Hemoglobin g/100 ml blood	Hematocrit (vol. %)	W.B.C. (cells/mm³ × 10⁻³)	% Granulocytes	Total granulocytes (cells/mm³ × 10⁻³)	Ratio of animals surviving
None	67	133	66	8.53	17.1	43.0	8.64	1.6	0.14	10/10
Thymine (150 mg/100 g)	66	141	75	7.91	17.9	41.8	7.02	1.7	0.12	10/10
Thymine (150 mg/100 g) + adenine sulfate (150 mg/100 g)	66	135	69	8.78	17.9	45.5	7.88	2.0	0.16	10/10
Thymine (150 mg/100 g) + adenosine (150 mg/100 g)	68	132	64	8.42	17.5	42.9	7.16	1.4	0.10	10/10
Folic acid (50 µg/100 g)	65	185	120	8.37	17.2	41.6	11.78	8.7	1.02	10/10

TABLE 2

EXPERIMENT 2. HEMATOPOIETIC EFFECT OF THYMONUCLEIC ACID ON FOLIC ACID-DEFICIENT RATS FED 2% SUCCINYL SULFATHIAZOLE

Supplement from 63rd day to 77th day	Weight in g at 63 days	Weight in g at 77 days	R. B. C. (cells/mm³) × 10⁻⁶ 63rd day	R. B. C. (cells/mm³) × 10⁻⁶ 77th day	Hemoglobin g/100 ml 63rd day	Hemoglobin g/100 ml 77th day	W. B. C. (cells/mm³) × 10⁻³ 63rd day	W. B. C. (cells/mm³) × 10⁻³ 77th day	Granulocytes (cells/mm³) × 10⁻³ 63rd day	Granulocytes (cells/mm³) × 10⁻³ 77th day	Ratio of animals surviving 77th day
2.1 µg folic acid	138	158	8.7	7.5	16.5	14.7	5.3	7.4	0.11	0.67	8/8
150 mg of thymonucleic acid ≅ 15 mg of thymine	131	122	8.6	6.8	15.7	13.2	4.8	2.0	0.08	0.08	8/8
5 µg folic acid	140	179	8.7	7.5	16.4	15.2	5.6	9.7	0.12	1.43	10/10

The possibility exists that folic acid may serve essential functions in the animal body other than hematopoiesis; and whereas thymine and adenine may replace folic acid for these, they do not do so for hematopoiesis, which is the limiting function in the experiments described here.

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Use of Silicones in Aerobiology

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In studies of organic and inorganic materials of the air, particularly in the epidemiology of rusts and other fungus diseases (*4*) and in allergy studies with pollen grains (*1*), it has been common practice to collect the specimens on glass slides covered with some adhesive such as vaseline, glycerine-jelly, or oil. In our investigations of airborne fungi and bacteria we have encountered temperatures as low as −48° C. At such low temperatures ordinary adhesives become too viscous or congeal and are unsatisfactory. The silicones made by the Dow Corning Corporation[1] seemed to offer possibilities as a substitute for the usual adhesives because of their retention of physical properties at low as well as high temperatures, and they were accordingly investigated. They have proved to be so satisfactory that it is considered worth while to call these new techniques to the attention of workers in this and related fields.

Slides coated with silicone grease (DC-4-ANC-128-A) have been used successfully in collecting rust, smut, and *Alternaria* spores from the air. Such preparations are superior to vaseline-coated slides for the following reasons: (1) The background is white, making an effective contrast. (2) The consistency remains unchanged at temperatures ranging from −75° C to over 200° C. (3) The slides can be sterilized, if desired, in dry heat for 2 hr at 180° C. Many other silicones are available which might also be used for this and similar purposes.

In ordinary studies of airborne fungi and bacteria, exposure of agar plates from airplanes has been common practice (*3*, *5*). However, Proctor and Parker (*1*, p. 49) have shown that agar plates exposed to low temperatures will freeze and give sterile readings even in nonsterile air. This problem has been overcome by coating the bottom of a Petri plate with silicone grease, sterilizing at 180° C for 2 hr, exposing the plates from an airplane and pouring in melted agar on return to the laboratory. Under these conditions, bacteria and fungi produce satisfactory colonies. Fungi grow through the overlying agar to the surface and sporulate normally; bacteria and yeasts develop between the two layers, forming typical subsurface colonies. Some bacteria are freed when agar is poured in and colonies develop in or on the agar. Isolations from any of these colonies can be made without difficulty. The principal advantage of this method is that plates may be exposed to extremely low temperatures for an indefinite period without any physical change or danger of freezing. By this technique cultures have been obtained from plates which were exposed to air temperatures as low as −48° C.

It would appear to us that these two methods might prove very useful in many phases of aeromycology and aerobacteriology, particularly where exposures are to be made at low or high temperatures. In routine exposures for stem and leaf rust studies, as well as for other cereal pathogens, silicones appear to be more satisfactory than vaseline. They should also be very satisfactory for the collection of pollen grains in allergy and other studies. For collecting microfauna and even small insects, the silicones would probably work equally well. They should prove of value also in fields other than aerobiology, particularly in snowflake and ice crystal investigation, and in studies of dust at high altitudes or even in the stratosphere.

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[1] Experimental material supplied by Dr. M. J. Hunter, Research Director, whose cooperation is gratefully acknowledged.

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Relation of Surface Phagocytosis to the Fibrinous Character of Acute Bacterial Exudates[1]

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Evidence has recently been presented that encapsulated bacteria which cause acute respiratory disease are phagocyted in the body in the absence of opsonins by a mechanism termed "surface phagocytosis" (*2*, *3*). Leucocytes operating in the presence of various tissue structures have been observed to ingest and destroy type I pneumococci, Friedlander's bacilli, group A hemolytic streptococci, and staphylococci (*7*). Although the encapsulated bacteria escape phagocytosis when floating freely in a fluid medium, they are readily phagocyted when trapped against tissue structures by the leucocytes. Also, when caught in a sufficiently dense concentration of leucocytes, they may be pinned between the surfaces of two or more cells and thus phagocyted (*6*). Of the microorganisms so far studied, only type III pneumococcus is resistant to surface phagocytosis (*5*). Its ability to escape the leucocytic pseudopods has been shown to be due to an outer "slime layer" of capsular polysaccharide which is present only when the organism is multiplying rapidly. When the slime layer is lost with aging of the bacterial population, type III pneumococcus becomes susceptible to surface phagocytosis.

Since leucocytes utilize tissue structures in phagocyting encapsulated bacteria in the absence of antibody, it would seem likely that they may utilize in a similar manner the fibrinous strands that characteristically occur

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[1] Aided by a grant from the Commonwealth Fund.

in acute bacterial exudates. To test this possibility, the following experiments were performed.

Type I pneumococci (A-5 strain) harvested from 4-hr broth cultures, were washed in gelatin-Locke's solution and centrifugalized (*8*). To the pneumococcal centrifugate were added rat leucocytes (*2*) which had been washed in the cold (4° C) in both gelatin-Locke's solution and citrated rat plasma[2] containing platelets from the buffy coat. (The platelets were included to insure clot retraction when thrombin was added to the plasma.) The final leucocyte-pneumococcus suspension in plasma contained approximately 5–10 phagocytic cells and 25–30 pneumococci per oil immersion field. Phagocytic tests were carried out on glass cover slips coated with dry film[3] to prevent spontaneous clotting of the plasma. When clotting was desired, one part of gelatin-Locke's solution containing 20 mg % of purified beef thrombin[4] was added to five parts of the cell-plasma suspension. In all control preparations one part of gelatin-Locke's solution without thrombin was added. The cover slip preparations were covered with hollow ground slides, sealed with vaseline, and incubated for 1 hr at 37° C. Smears from the incubated preparations were stained with methylene blue. Clotted samples were fixed in Zenker-formol solution, sectioned, and stained by the Gram-Weigert technique.

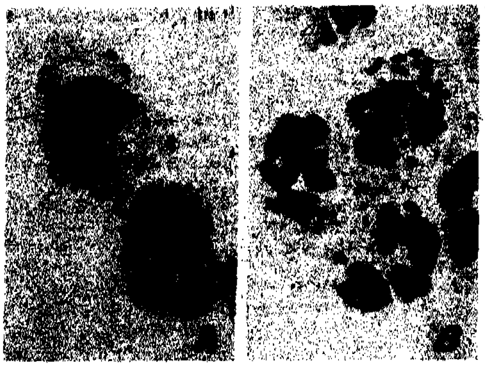

FIG. 1. *A*—Phagocytic test in unclotted plasma. *B*—Phagocytic test in clotted plasma.

As is seen in Fig. 1, phagocytosis failed to occur in unclotted plasma (*A*), whereas in clotted preparations (*B*) the phagocytosis was marked.

In order to observe the manner in which the leucocytes utilize the fibrinous strands in phagocyting unopsonized pneumococci, pneumococcus-leucocyte mixtures in clotted plasma were studied in the warm stage of the microscope. Near the margins of the clot, phagocytosis was seen to result only when leucocytes succeeded in pinning the pneumococci against the fibrin strands. From this observation it was evident that the mechanism *of surface* phagocytosis in fibrin clots is essentially the same as that previously described in the lung (*2*, *7*, *8*).

Fibrin formation is a common feature of acute inflammation. Fibrinous exudates occur in acute bacterial infections of the lungs, pleura, peritoneum, meninges, and other tissues of the body. A significant portion of the fibrinous material in purulent exudates has recently been identified as desoxyribose nucleoprotein (*1*). Although beta hemolytic streptococcal exudates (group A) are relatively poor in both fibrin and desoxyribose nucleoprotein (*3*), most other bacterial exudates contain appreciable amounts of reticular substance. The present study demonstrates that *strands of reticulum enable* leucocytes to phagocyte encapsulated bacteria in the absence of antibody. Thus it may be concluded that the fibrinous properties of early bacterial exudates contribute to antibacterial defense by promoting surface phagocytosis. In chronic infections, on the other hand, where most of the leucocytes in the exudate are nonviable, the fibrinous strands may act as a mechanical barrier to recovery by interfering with adequate drainage of the lesions.

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[2] Rat plasma has been shown to contain no *opsonins* to the A-5 strain of pneumococcus I.

[3] General Electric, Organosilicon Product, 9987.

[4] Obtained through the courtesy of Dr. T. E. Weichselbaum,

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A Method for Preventing Moisture Condensation During Photography of Tissue Cultures in Hanging Drops

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When tissue cultures grown in hanging drops over depression slides are taken from an incubator (37° C) and kept at room temperature, moisture condenses on the cover slip in the form of drops. These drops make it impossible to get clear photographs of the tissues. Various means have been devised to prevent condensation—the most common one is to keep the culture at incubator temperature. To accomplish this, some form of heating apparatus is placed on or near the stage of the microscope, but this may be a tedious process.

A simple procedure for preventing moisture from collecting on the cover slip has been devised. It consists of saturating the atmosphere around the culture with moisture and keeping the temperature fairly constant. Brass rings, such as those used by W. H. Lewis in his tissue culture work, are used. He found them useful for photomicrography, since they held the cultures at a uniform height above the slide.

These brass rings are 1 mm thick with a 25-mm outside diam and a 19–20 mm inside diam. About one-fourth of the ring is cut away, leaving it incomplete. The ring, held by forceps, is heated over a flame and then dropped into a dish of salvoline (6 parts vaseline and 1 part paraffin). It quickly sinks below the surface. It is then picked up, the excess salvoline is drained off and the ring, now completely covered with salvoline, is placed on an ordinary glass slide, well cleaned with 70% alcohol. When cool and hard, the salvoline holds the ring in place. The space enclosed by the ring is then filled with distilled water, most of which is at once drained off, leaving the surface of the slide within the ring covered with a thin film of water.

The cover glass containing the tissue culture is removed from its depression slide and placed on the brass ring. The salvoline holds it firmly in place. The layer of water inside the ring keeps the atmosphere around the culture saturated with water at a fairly constant temperature, so that water does not condense on the cover slip. If necessary, more water can be added to the space in the ring by means of a fine pipette placed at the opening in the ring. The tissue culture never comes in contact with the water. After photographing, the cover slip with its tissue culture is returned to its glass depression slide and the brass ring is ready for use again. Sometimes it may be necessary to add more salvoline to the top of the ring. This is easily done with a glass pipette filled with salvoline. The slide inside the ring must be completely free of salvoline. If it is not, then a freshly cleaned slide must be used; otherwise the distilled water will not form a thin even film over the glass slide. Glass rings or plastic rings can be used instead of brass rings.

Enzymatic Decomposition of Lignin[1]

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Numerous claims have been made in the literature purporting to demonstrate the ability of microorganisms to utilize lignin as a sole carbon source, or purporting to demonstrate the existence of enzymes acting specifically on the lignin molecule. These reports are based on techniques which presuppose that lignin isolated by acid or alkaline treatment of plant material undergoes no important changes during its isolation (*8*, *9*, *10*, *13*, *15*) or that various color reactions can be used to detect the presence or disappearance of lignin (*2*, *6*). Some work has been based on the assumed similarity in structure between lignin and tannic acid (*1*). Advances in our understanding of the chemistry of lignin indicate that these suppositions are very dubious (*5*, *12*, *14*). The work of Brauns (*3*, *4*) in isolating so-called "native lignin" by a process which minimizes structural alterations in the lignin molecule seemed to us to warrant an experimental reexamination of the ability of microorganisms to utilize isolated lignin and of the possible existence of lignin-oxidizing enzymes. Results of these studies to date are summarized here in a preliminary manner.

Lignin was prepared from 12-yr-old red sprucewood by the method of Brauns, and used in both nutritional and enzyme studies with fungi.

After a survey of a large number of species of wood-rotting fungi, good growth of several of these organisms was obtained after two weeks' incubation on media in which lignin was the limiting carbon source. This material will be reported in a separate communication (*7*).

Studies on a lignin-oxidizing enzyme were carried out, using the absorption of oxygen measured in a Warburg manometric apparatus as an indication of enzyme activity. A reliable source of enzyme was found to be commercial mushroom spawn,[2] which is an intimate mixture of mycelium of *Agaricus campestris* and well-decomposed horse manure. Conditions used in the preparation of this material are such that it is essentially a pure culture of this organism. A dry, stable preparation of the enzyme has been obtained by the following procedure:

Mushroom spawn is mixed with three times its weight of distilled water in a Waring Blendor for 3 min. The resulting mash is subjected to a pressure of 15,000 psi in a Carver press and the press juice is dialyzed for 48 hr in Visking cellulose sausage casing against cold running tap water. The dialyzed solution is removed from the casing, cooled to 5° C, and to it is added two volumes of cold acetone. The resulting precipitated solution is cooled to 5° C, and the brown precipitate is centrifuged down and washed twice with cold 66% acetone. The precipitate is finally dried at 35° C under aspirator pressure. One lb of spawn yields 2–3 g of this dry preparation. The concentration of solids is reduced from 20 mg/ml in the original press juice to 6 mg/ml in the dialysed solution, and to 2 mg in the acetone precipitate.

The enzyme is activated by citrate and phosphate ions and it is therefore buffered to pH 6.0 with McIlvaine's buffer (*11*) for activity measurements. Under these conditions 75 cu mm of oxygen are absorbed in the first hour when 1 ml of an aqueous solution containing 3 mg of enzyme is incubated with 1 ml of an aqueous lignin suspension containing 30 mg lignin/ml. The enzyme is quite stable in acid solution (pH 4.0–6.5), but loses activity rapidly at pH values higher than 7. The pH optimum for enzyme activity is 5.7–6.0, with a temperature optimum close to 40° C. Under optimum conditions, the activity of a solution of enzyme is proportional to its concentration.

It is believed that this enzyme is not identical with any of the known phenol oxidases, since mushroom sporo-

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[1] This work was done under Contract No. N7 onr 397-4 between the University of Maryland and the Office of Naval Research. The project was initiated at the suggestion of the Prevention of Deterioration Center, National Research Council.

[2] The mushroom spawn used in these experiments was obtained from the L. F. Lambert Company, Coatesville, Pennsylvania.

phores (a recognized source of tyrosinase) do not yield a product having activity. The enzyme is not activated by copper ions and is completely inactivated at pH values higher than 7. A study of the action of various enzyme inhibitors supports the nonidentity of this enzyme with any of the known copper-containing enzymes.

Studies are now in progress on the effect of this enzymatic reaction on the structure of the lignin molecule and on further purification of the enzyme. A detailed account of the work summarized here will be published in another journal.

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The Hemostatic Activity of Amniotic Fluid[1]

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During studies of the coagulation mechanism in pregnancy it seemed of interest to investigate the action of amniotic fluid. This fluid was collected in a sterile syringe by aspirating the intact membranes of women in labor. The Lee and White clotting test was done, using four 12 × 75-mm glass tubes. One-tenth cc of amniotic fluid was added to each of two tubes and an equal amount of saline to each of two control tubes. Freshly drawn venous blood was added in 2-cc amounts to all four tubes, which were then incubated at 37° C. The end point taken was that at which both tubes of each set could be inverted completely without spilling. Results are shown in Table 1.

It can be seen that one part amniotic fluid, when added to twenty parts of blood, can cut in half the time required for clotting.

It appeared that by studying the behavior of amniotic fluid with oxalated plasma and fibrinogen solution[2] we might be able to identify its place in the coagulation mechanism. The effect of amniotic fluid on the rapidity of clot formation in recalcified plasma is illustrated in Table 2. These data indicate that amniotic fluid decreases the clotting time of recalcified oxalated plasma.

TABLE 1

Clotting Time

Specimen	Number of tests	Controls	With amniotic fluid
		Min	*Min*
A1-10	5	7.0	3.5
A1-21	3	7.5	3.0
A1-20K	4	7.8	3.4
A1-19W	3	7.1	3.4
A1-25S	6	7.5	6.0
A1-27	3	5.8	4.2
A1-28	7	6.8	3.6
A1-30G	15	8.0	3.6
A1-31	4	8.7	2.8
A2- 4	7	10.0	3.9
A2- 4S	3	8.0	2.6
A2- 5A	8	9.0	4.0
A2- 5N	5	9.8	2.7
A2- 5S	5	9.6	3.4
A2- 9W	5	7.5	3.6
A2-15A	4	8.3	3.5
A2-24	4	7.7	3.1
A2-25B	8	10.0	3.7
A2-24N	3	7.5	3.1
A3- 1G	5	8.7	2.4
A3- 2W	5	9.2	3.9

TABLE 2

Recalcification Time

Specimen	Controls*	Plus 0.1 cc amniotic fluid†
	Sec	*Sec*
A1-10	76	46
A1-21	85	55
A1-20K	100	60
A1-19W	85	25
A1-25S	142	71
A1-27	131	55
A1-28	177	52
A1-30G	145	42
A1-31	111	47
A2- 4	140	56
A2- 4S	125	49
A2- 5A	93	58
A2- 5N	97	87
A2- 5S	110	61
A2- 9W	98	56
A2-15A	115	59
A2-24	135	65
A2-25B	145	73
A2-24N	145	68
A3- 1G	137	61
A3- 2W	120	30

* Recalcification time for 0.1 cc of 0.025 m calcium chloride, plus 0.1 cc physiologic saline, and 0.1 cc fresh plasma (0.5 cc of 0.1 m sodium oxalate to 4.5 cc blood).

† Substituting 0.1 cc fresh amniotic fluid for saline in recalcification.

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[1] Supported in part by grants from the Blood Grouping Laboratory, Children's Hospital, Boston, Massachusetts, and the Charles H. Hood Foundation, Boston, Massachusetts.

[2] Supplied by courtesy of Dr. John Edsall, Department of Physical Chemistry, Harvard Medical School, Boston.

Preliminary experiments showed that amniotic fluid alone would not clot oxalated plasma; therefore it does not act like thrombin or trypsin, which clot oxalated plasma without added calcium. Amniotic fluid contains no prothrombin, since a clot will not form in prothrombin-free, oxalated plasma on the addition of calcium, thromboplastin, and amniotic fluid. Amniotic fluid does not decrease the plasma prothrombin time in the one-stage method.

TABLE 3

CLOTTING TIME

Specimen	Hemophilic blood	With 0.1 cc amniotic fluid
	min.	*min.*
A2-24	54	4
A2-25B	54	3.8
A3- 1G	54	3.5
A3- 2W	54	3.9

Amniotic fluid has a marked antihemophilic action *in vitro*. Table 3 shows the effect of .1 cc of amniotic fluid on the clotting time of a hemophiliac who was resistant to therapy with Fraction 1 and fresh frozen plasma. It can be seen that the amniotic fluids produced clotting times with hemophilic blood comparable to those they gave with normal blood, whereas the hemophilic control tubes clotted in 54 min.

It would appear that amniotic fluid acts like thromboplastin in its effect on oxalated plasma. This activity is preserved for several days by storage in the deep freeze at − 10° C but deteriorates within 1–3 days on standing at room temperature or in the ice box. The activity is nondialyzable. Boiling strongly for 5 min destroys it, although it is stable at 60° C for 30 min. Furthermore, it is entirely inactivated by small amounts of heparin. Various incubation tests which were done with amniotic fluid and fibrinogen clot or plasma clot showed no evidence of fibrinolytic power in amniotic fluid. Clotting tests of amniotic fluid with fibrinogen solution verify the lack of thrombic or prothrombic activity.

Uncontaminated amniotic fluid collected during labor contains a coagulant. This coagulant is thromboplastic in its behavior and antihemophilic. It is possible that amniotic fluid initiates clotting of shed intra-uterine blood and therefore plays an important part in normal postpartum hemostasis.

Comments and Communications

The AEC Loyalty Oath

A letter that I wrote some time ago to Dr. Detlev W. Bronk, chairman of the National Research Council, in connection with the loyalty oaths now required of Atomic Energy Commission Fellows, is still timely. One of the points made in this letter is, indeed, strongly emphasized by the recent proposal, embodied in the O'Mahoney Amendment to the Independent Offices Appropriation Bill, for a mandatory FBI investigation of all AEC fellows: namely, the point that it is difficult to contain measures of this kind within those bounds which might be suggested by prudence or by a decent instinct of self-restraint.

Basically, the issue here is one of political freedom. The denial of educational rights or privileges to a citizen who would be eligible for them were it not for his failure to measure up to some arbitrary political test is a clear violation of the principles upon which our republic was founded. The essence of the matter has been stated with complete clarity by Mr. Justice Stone in his celebrated dissenting opinion (later adopted by a unanimous court in a spectacular reversal of its decision) in the so-called "Flag Salute Case"—Minersville School District *et al.*, vs. Gobitis, 310 US 601. That opinion should be read by anyone interested in the present discussion. Any attempt to distinguish between the situation met in the "Flag Salute Case" and the present one will only bring out the fact that the distinctions are completely secondary.

My letter follows:

> Dear Dr. Bronk:
>
> The statement issued by the Atomic Energy Commission on May 22 concerning the oaths and affidavits which will *henceforth be required of holders of A. E. C. Fellowships* is now available in its entirety, as published on page 552 of "Science" for May 27, 1949. Previous fragmentary reports concerning this statement had caused me to weigh its possible implications with great care. As a member of one of the boards created by the Council to pass on applicants for the A. E. C. Fellowships, I felt I should formulate and make explicit my own attitude toward the new situation. With the publication of the full statement before me, I am now able to arrive at a definite conclusion. I am therefore writing you to request that my resignation from the Postdoctoral A. E. C. Fellowship Board for Mathematics, Physics, and Chemistry, already placed in your hands under date of May 10 for reasons of a purely practical nature, be made effective at once.
>
> A full statement of my reasons for this request would doubtless be inordinately long. There are, however, three main points which I might make here by way of briefly explaining those reasons. Fundamentally, it seems to me, the imposition of political conditions upon the pursuit of scholarship, however supported, is contrary to the political principles on which our nation is founded; prejudicial to the proper development of basic research in the United States; and most difficult to contain within those limits which the proponents of the current measures appear to accept as necessary. If I were not opposed to these measures on grounds of principle, I would nevertheless wish to withdraw from the atmosphere of suspicion which they will inevitably generate unless they are modified in the sequel by a practice of confining loyalty investigations of fellowship holders to those cases where classi-

fied research is involved. Finally, even if the submission of sworn statements were to be reduced in this manner to a kind of empty ritual, it would nevertheless be a ritual in which many a young man, already idealistically dedicated in his own eyes to the service of his countrymen, would participate only with a certain sense of humiliation and a corresponding feeling of resentment; and I could not bring myself to continue a remote but identifiable association with the compulsion to participate. On this last point I recall with clarity the feelings I experienced when required to take the so-called Teacher's Oath some years ago in Massachusetts, an oath which I could and did take with a perfectly clear conscience and without reservations.

You will understand, I am sure, that this letter, being an expression of conscientious beliefs and not a discussion of mere practical arrangements, is a communication which I do not feel bound to hold private.

Marshall H. Stone

The University of Chicago

Method for Supplying a Laboratory with Warm Sea Water in Winter

One of the handicaps faced by the biologist working in northern waters is the long winter period when the water temperature is too low for active functioning of many invertebrates. In our case this period, when the water temperature in Long Island Sound is 5.0° C or less, may extend from four to almost five months. In severe winters a temperature of −1.5° C is often recorded (Loosanoff, V. L., *Ecology*, 1937, 18, 506). Under such conditions many forms are hibernating, while others are less active than at higher temperatures.

During the last five years we tried to overcome this difficulty by artificially increasing the temperature of sea water used in our experiments. The first attempts, which consisted in maintaining a high temperature in the experimental aquaria by means of electric heaters, were rather promising because they showed that oysters kept under such conditions could be induced to develop ripe eggs and spermatozoa even in the middle of winter (Loosanoff, V. L., *Science*, 1945, 102, 124). However, since the use of electric heaters was rather expensive, and because there were certain objections to keeping metal heaters and experimental animals in the same water, we did not consider the method entirely satisfactory and continued to seek a better one.

The principle of our present method is rather simple. Cold sea water is passed through a coiled lead pipe, which is immersed in a large tank filled with warm fresh water. The temperature of this water is maintained at the desired level by a gas flame regulated by a pilot light thermostat (Fig. 1, A). The temperature of sea water in the lead pipe leaving the tank is regulated by an electric thermostat, the bulb of which is attached to the pipe itself. This thermostat is also connected to the magnetic gas valve (Fig. 1, B) of the gas burner. If the temperature of outgoing warm sea water in the lead pipe decreases below a certain minimum, the thermostat sends a signal to the magnetic gas valve, which increases the gas flame. To prevent the stratification of warmer water in the upper part of the tank, a strong stream of air bubbles is continuously passed through the tank. In general, the system is simple and can be installed by a person familiar with installation of domestic hot water heaters. Ours was installed by our laboratory mechanic, Joseph Lucash.

The advantages of having warm running sea water in a laboratory are numerous, the most obvious being the possibility of conducting throughout or almost throughout the year many experiments which formerly had to be confined to the relatively short summer period. For example, by subjecting adult clams, *Venus mercenaria*, to gradually increasing temperatures during January, we induced them to spawn in February and March and grew their larvae to metamorphosis. For several years oysters were conditioned in the same way, and recently my colleague, Harry C. Davis, was successful in obtaining heavy sets of oysters in the middle of winter. No doubt similar success can be achieved with other forms which normally are inactive in winter.

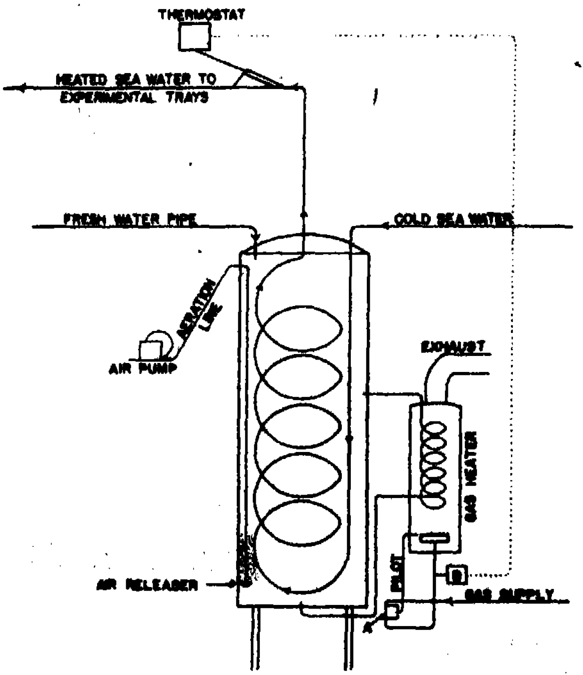

Fig. 1. Diagram showing method of raising temperature of cold sea water.

By keeping the animals during the cold period at desired temperatures, laboratories can be assured of a sufficient supply of biological material, which is ordinarily unavailable in winter. For instance, we already know on the basis of our experience that embryological studies on eggs of some lamellibranchs can now be continued on almost a year-round basis. Thus, at least in this respect, we can hope to accomplish as much in one year now as could be done formerly in three or four.

Another advantage of a continuous supply of warm sea water in winter is that it is so easy to maintain streams of different temperatures by mixing warm and cold water in different proportions. We use streams of about 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, and even 35.0° C.

Water of such temperatures, or any other temperatures within this range, can be prepared by having constant level jars of cold and warm water and by regulating the flow from these jars into a mixing chamber where the desired temperature is attained. From the mixing chamber the water will flow into the trays or aquaria containing the experimental animals. Because the temperature of our cold water is very uniform, adjustments are seldom necessary to compensate for fluctuations.

Having running water of different temperatures offers an opportunity to experiment simultaneously with groups of organisms kept at such temperatures. For example, we used our facilities for observations on growth of adult oysters at temperatures of 10.0, 15.0, 20.0, 25.0, and 30.0° C; on development of eggs and growth of larvae of different mollusks; in studies of some phases of physiology of oysters and clams, such as gonad development and spawning; and in many other experiments.

VICTOR L. LOOSANOFF

Fish and Wildlife Service, Milford, Connecticut

Toxicity and the Chemical Properties of Ions[1]

The mechanism of the toxic action of drugs has long been a controversial subject. Attempts at an elucidation of the problem include correlations between toxicity and molecular properties. The older physiologists and medical men are, in the main, opposed to any such correlation; the younger biochemists are for it. The more conservative investigators have much negative evidence to support their view, for usually when a drug is administered no one has the slightest idea what happens thereafter, other than the end result. Those who believe in an association between the physiological effect and molecular pattern of a poison have little evidence but much confidence to support their view—a view which they regard as the intelligent one, for, to what else can toxicity be due?

A study of the poisonous action of inorganic salts on slime molds should simplify matters, for the ion of a metal has a far less intricate structure than, for example, a molecule of cocaine, and a primitive form of life is devoid of the complexities of higher organisms.

The slime molds are Myxomycetes to the botanists, who regard them as plants, and Mycetozoa to the zoologists, who think these molds are animals. To medical men, slime molds are just protoplasm, far removed from the intricacies of the human body and therefore having little bearing on medical physiology. But perhaps the difference between the protoplasm of lowly organisms and that of higher forms of life is not always as great as imagined. Lacking the differentiations which tissues present, the protoplasm of a slime mold reveals correlations which are obscured in highly complex organisms. Furthermore, the visible effect of a toxic agent on a slime mold may be directly observed through the microscope.

The degree of toxicity of a poison acting on a slime mold is determined by a number of pathological changes which occur in the protoplasm; among them are the *periods of time necessary to kill, to stop protoplasmic* flow, and to produce injury. The degree and kind of injury are also significant criteria; among these are gelation, solation, syneresis, blistering, surface rupture, and general disorganization.

Results of studies on the poisonous actions of anesthetic agents, drugs, and metallic salts on protoplasm were reported at an Army Symposium in June 1948.[2] The discussion there, and later elsewhere, led to numerous comments and criticisms, both adverse and constructive. They are repeated here in the belief that they will prove of interest not only to toxicologists, biologists, and medical research workers, but to chemists as well, for they deal as much with the physical chemistry of solution as with toxicity.

I had found a correlation between the anesthetic effects of CO_2 and N_2O and their isosteric properties (*Science*, 1948, 107, 15). The correlation was questioned because, *so it was said, the protoplasm is not in contact* with the gas, CO_2, but with carbonic acid. This is an old problem, and has long since been answered by both biologists and chemists. Of the several kinds of molecules and ions which CO_2 in water may present, it can be experimentally shown, by a process of elimination, that only the CO_2 molecule is responsible for anesthetic and other toxic effects. There are several ingenious experiments in physiology which demonstrate, by taste and color indicators, that *an acid condition* is established *within* living tissue when an *alkaline* solution is added outside, due to the rapid entrance of CO_2 as such. Few substances enter a cell as freely and as rapidly as does carbon dioxide, and it enters primarily as the CO_2 molecule.

The evidence from the physical-chemical side is of the same sort. H. B. Bull (*Physical biochemistry*, New York City: John Wiley, 1943) states that "at equilibrium, the amount of dissolved CO_2 is about 1000 times the amount of hydrated CO_2, i.e., of carbonic acid." This means that instead of having no free CO_2, there is some 99 percent of it when CO_2 is dissolved in water. The correlation between the isosteric and the anesthetic properties of the gas must, therefore, fall, if it is to fall, on other grounds.

A further criticism, directed against physical-chemical interpretations of the toxicity of metallic salts, involved the validity of the assumption that the metal ions are present as free ions. That hydrates and complexes are formed in solution is, of course, well known. Salts such as those of Al and Zn are particularly bothersome from this point of view and are therefore frequently omitted from toxicity series. They not only hydrolyze readily, forming weak bases, but produce soluble complexes, leading to such ions as $[Al(H_2O)_4(OH)_2]^+$.

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[1] A number of chemists have contributed to these comments, some of them unknown to me, speaking in group discussions. Rather than attempt to select those whose comments should be acknowledged, I shall express my indebtedness to all collectively, and disclaim for myself any credit for the more fertile suggestions. I need only add that the physiological work on the toxicity of salts reported here was done in my laboratory by myself and my assistant, whose presence I owe to the Sloan-Kettering Institute for Cancer Research.

[2] Army Chemical Center, Edgewood Arsenal, Maryland.

The case of mercury is a special one. $HgCl_2$ is but slightly dissociated in solution, and the concentration of Hg^{++} is correspondingly low. But mercury salts of oxygen acids are capable of giving high Hg^{++} concentrations. Mercury poisoning by $Hg(NO_3)_2$ is therefore due to free mercury ions.

$AgNO_3$, which I had regarded as a clear case of simple dissociation, was said to be another "troublemaker," an appellation which I had given to $ZnCl_2$ and $AlCl_3$. But this does not appear to be true of $AgNO_3$. The extent of hydrolysis of any given salt in aqueous solution can be calculated from the strength of the base, the metal hydroxide, and the acid. In the case of $AgNO_3$, hydrolysis and complex formation, if any, are negligible, and the solution can be considered as one of Ag^+ and NO_3^- ions.

As for $ZnCl_2$, it, too, in dilute solution, consists largely of the simple ions Zn^{++} and Cl^-. Hydrolysis, however, is great.

Accepting, therefore, as we apparently must, the fact that certain metals assumed to be responsible for the toxic effects of their salts are actually present as free ions in solution, we may seek in the physical and chemical properties of these ions an explanation of their toxicity.

A toxicity series such as $Na^+ < Ba^{++} < Au^{+++} < Th^{++++}$ is readily explained in terms of valence and charge. That such an analysis has some meaning is seen in the relative capacity of these ions to precipitate colloidal suspensions. But there are striking exceptions to a valence interpretation of toxicity. Monovalent Ag^+ is highly toxic, far more so than divalent Ca^{++} and trivalent La^{+++}. Very significant also is the fact that within any one valence group there are pronounced differences in toxicity. Thus, among the divalent cations, Ba is far more toxic than Ca.

Ionic series are frequent in chemistry and biology. The seriation is based on various reactions, on protein coagulation, sensory responses (FRINGS, H., *J. Comp. physiol. Psychol.*, 1948, 41, 25) cell permeability, adsorption, zeta potentials, and colloidal precipitation (FREUNDLICH, H., *Kapillarchemie*, Leipzig; Akademische Verlagsgesellschaft, 1934). Usually these lyotropic salt series are presented in one continuous line, but this is not always feasible, for there is frequently much overlapping; furthermore, the less toxic mono- and divalent ions often constitute a clear-cut series of increasing toxicity, whereas the more poisonous metals form a heterogeneous group. I prefer several distinct series, and I prefer, too, a staggered arrangement, as it better illustrates the experimental facts. For the protoplasm of slime molds, the complete toxicity grouping:

$$\begin{array}{l} Li^+ < Na^+ < K^+ < Rb^+ = Cs^+ \\ \qquad\qquad\qquad Ca^{++} < Mg^{++} < Sr^{++} < Ba^{++} \\ \qquad\qquad\qquad\qquad La^{+++} < Pb^{++} < Au^{+++} < Ag^+ < Th^{++++} \end{array}$$

The hydrogen ion, itself highly toxic, is not involved in the toxicity of the salt solutions here mentioned. The pH of all solutions used was near neutrality, and slime mold protoplasm thrives well at any pH above 4 and below 8.

Molecular interpretations of lyotropic series have been numerous. Valence and atomic weight are the first obvious correlations to be made with toxic effects. From top to bottom and left to right in the periodic table is the general rule for the increasing toxicity of the elements.

The unexpected position of certain ions in the third of the foregoing groups is more difficult of interpretation, but there are a number of atomic properties which appear to bear on the anomaly. The position of the ion in the electromotive force series correlates with toxicity to some extent. Five highly toxic elements, Cu, Ag, Hg, Pb, and Au are grouped together in the emf series. Of possible significance is the second electronic ring, that adjoining the outer valence orbit. Thus, Ag, Pb, and Au are all highly toxic and all have 18 electrons in the second orbit. The meaning of such a correlation would lie in its influence on the activity of the ions, on their tendency to form bonds with atoms which are part of the protoplasmic structure. Resonance is another property of molecules which has come into the biological picture of late. L. Pauling (*The nature of the chemical bond*, Ithaca, N. Y., Cornell Univ. Press, 1945) calls attention to resonance as a likely factor in physiological activities, to which W. T. Astbury (chapter in *The structure of protoplasm*, Ed. by William Seifriz, Ames, Iowa: State College Press, 1942) adds, "It may well be that resonance and the hydrogen bond are of more importance to physiology than any other two facts in chemistry."

It is upon still another property of ions that I wish to lay particular emphasis. There is a very close correlation between the toxic action of ions and their hydration. Protoplasm is largely water and lives in an aqueous medium. Hydration must, therefore, play a major role in physiological reactions. The order of hydration of the monovalent ions is: $Li > Na > K > Rb = Cs$; for the divalent metals it is: $Ca > Mg > Sr > Ba$. These are both the order of increasing toxicity. Relative hydration, therefore, correlates perfectly with degree of toxicity.

Some questions have arisen over types of hydration, over arrangement and density of the hydration layer. I therefore quote J. D. Bernal and R. H. Fowler (*J. chem. Phys.*, 1933, 1, 515) who state simply that Cs^+ is not hydrated and Li^+ is highly hydrated.

Water is an associated molecule, tetrahedral in structure. Bernal and Fowler compute ionic hydration from the maximum packing of the tetrahedrons, and find the order of hydration of the monovalent cations to be as given above, which agrees with results from all other sources (HARNED, H. S. and OWEN, B. B. *The physical chemistry of electrolytic solutions*, New York City: Reinhold, 1943.)

Harned and Owen point out that the ionic field is $\frac{1}{p^2}$, and hydration is, therefore, in inverse ratio to the ionic radius. The radius of the Li^+ ion is small enough to attract water molecules, whereas the large Cs^+ ion does not permit the ion to hold a water layer. Thus do ionic radii, fields, hydration, and toxic effects run parallel to each other.

The role of hydration is a shielding one. It determines whether or not a toxic ion can exert its effect, but it does not determine the innate toxicity of the ion; i.e., if an ion is in itself not toxic, the absence of a protective water layer cannot make it so. A hydrated layer can protect but it cannot activate. Mobility is a measure of the activity of the ion and therefore must determine, in part, the nature of the reaction between ion and protoplasm.

The order of mobilities of five monovalent ions is (BRIGGS, D. R. *J. phys. Chem.*, 1928, 32, 1646):

Li	Na	K	Cs	H
33.4	43.5	64.6	68.0	315.0

and this is the toxicity order. But mobility is itself dependent upon hydration. The order of ionic mobility parallels that of hydration and therefore of the toxicity of the mono- and divalent ions. Cs^+ is about twice as mobile as Li^+. Li^+, as $Li^+ \cdot nH_2O$, becomes then the ion with the smallest radius, greatest field, maximum hydration, minimum mobility, and least toxic ion in the series. Cs and Rb, with numerous electron shells and therefore large radii, have weak fields, low hydration, and high mobility. They are, consequently, more toxic, being more active and having more direct contact with the protoplasm. The difference in the fields of Cs and Rb is slight; one would, therefore, expect that there would be slight difference in their toxic effects, and this proves to be true—it is difficult to distinguish the poisonous action of the two.

The third group of ions listed above is a heterogeneous one. The highly toxic Th^{++++} ion is of large size, heavy weight, great charge, and low hydration; Au^{+++} is the same; Pb^{++} also, but to a lesser degree. Their toxicity therefore correlates with their physical qualities. The toxicity of La^{+++}, however, is surprisingly low for a trivalent metal, being less than Ba^{++}. Trivalent Au^{+++}, on the other hand, is highly toxic. Hydration helps in part to set the matter straight. If we compare Ba^{++}, La^{+++}, and Au^{+++}, we find that Ba^{++} is highly toxic for a bivalent metal; its charge is not excessive but its hydration is low. La^{+++} is a heavy metal ion of large size and great charge; it should therefore be quite toxic, but it is much more heavily hydrated than Ba^{++}; the protoplasm is consequently protected against it. Au^{+++} has all the properties of La^{+++} except its hydration; it should therefore be highly poisonous, and this it is.

Ag^+, because of its position in the third group with other exceedingly toxic elements, presents a special case. It is a large ion, and not highly hydrated, but these two facts alone are not enough to establish its high toxicity. The reaction between protoplasm and an ion is determined by the thermodynamic properties of the ion and by the selectivity of protoplasm. The former include the several properties so far presented, but they are not equally effective. Mobility and hydration dominate among the lighter elements. These two properties become increasingly less significant with increase in atomic weight. Among the heavier metals, mobility and hydration play a lesser part.

Electronegativity, indicated by position in the emf series, determines the force with which a metal attracts electrons and therefore the ease with which it forms combinations with other substances. In the present case, these other substances are the protein constituents of protoplasm. Thus may we say that ionic mobility is a primary factor in determining toxicity among the lighter metals, whereas electronegativity is primarily the factor in determining the toxicity of the heavy metals. The long-recognized correlation between toxicity and atomic weight is here realized. Mobility decreases with atomic weight, but electronegativity increases, being greatest in the noble metals, among which Th, Ag, Au, Hg, etc., are the most poisonous of elements.

My interest in those physical properties of metals and organic compounds which explain their toxicity has centered primarily in the hydration and mobility of ions and in the structural patterns of molecules; but the further one looks into other properties the more nearly perfect the parallelism becomes. This is seen in the isosteric properties of CO_2 and N_2O (LANGMUIR, I., *J. Amer. chem. Soc.*, 1919, 41, 1543). It is also obvious in a number of other properties of those elements considered here. The coagulating power of ions is of the same order as their ionic mobilities (PAPPADÀ, N. *Kolloid Z.*, 1909, 14, 56). Furthermore, an ion which moves into an interface readily, because of high mobility, will for the same reason lower the potential and the surface energy.

Adsorption, likewise, nicely parallels both the physical and the physiological properties of ions. G. W. Scarth (*General physiology*, New York City: John Wiley, 1930) points this out in listing the order of adsorbability, which for the monovalent and divalent ions is that of the toxicity order given above. For certain ions, including some of those in the third heterogeneous group, the order of increasing adsorbability by charcoal is: $Na < K < Ca < Zn < La < Cu < Hg < Ag$. Adsorbability is thus seen to increase with valence, mobility, and capillary activity among the lighter elements. Among the heavier metals, electronegativity, i.e., position in the emf series, is the dominant factor in determining adsorbability. The nobler the metal the more strongly it holds its electrons, the greater it is adsorbed, and the greater is its toxicity.

When numerous physicochemical properties correlate with toxicity it is impossible to know where to lay the emphasis. All play their parts in different ways. The important point at the moment is that all correlate with the relative toxicity of the ions.

Toxicity, in the last analysis, involves an interaction between the poison and a specific component of protoplasm. Selectivity between ions and certain chemical groups is recognized. J. Northrop (*J. gen. Physiol.*, 1928, 11, 480) has shown that Cu combines primarily with the NH_2 groups of gelatin whereas La combines at some other point. Particularly important in the present discussion is the knowledge that the heavy metals, such conduct basic research into the development and organization of personality through the assessment of individuals in a variety of fields and especially of persons applying for admission to professional schools of the university.

The J. Shelton Horsley Research Award of the Virginia Academy of Science has been presented to W. S. Flory, Jr., of the Blandy Experimental Farm, University of Virginia. Dr. Flory was honored for his study on pollen condition in some species and hybrids of *Rosa* with a consideration of associated phylogenetic factors.

The College of Physicians of Philadelphia awarded the **Alvarenga Prize** for 1949 to Owen Harding Wangensteen, professor of surgery, University of Minnesota, for his contributions to the etiology and therapy of gastric and duodenal ulcer. Dr. Wangensteen will deliver the Alvarenga Lecture on this subject at the college on November 2.

The Jane Coffin Childs Memorial Fund for Medical Research has announced the following appropriations totaling $92,435 for support of cancer research projects and fellowships during the academic year 1949–50: *F. Duran-Reynals*, Bacteriology Department, Yale University School of Medicine, $7,500 for the third year of his grant for the study of the relation of viruses to tumors; *Samuel C. Harvey*, Oncology Department, Yale University School of Medicine, $8,500 for clinical and laboratory studies of cancer; *C. C. Little*, Roscoe B. Jackson Memorial Laboratory, $4,500 for investigations on the mammary tumor inciter and related problems; *Eugene L. Opie*, Rockefeller Institute for Medical Research, $8,000 for studies on osmotic and cytological effects of hepatic tumor-producing diets; *Arthur Kirschbaum*, Department of Anatomy, University of Minnesota Medical School, $2,900 for studies on the induction and therapy of leukemia and other neoplasms of mice; *Alexander Haddow* and his associates at the Chester Beatty Research Institute of the Royal Cancer Hospital, London, $5,000 for investigations on the chemistry, virology, and chemotherapy of cancer; *E. S. Gusman Barron*, Biochemistry Department, University of Chicago, $10,000 for studies of the metabolism of blood cells and of blood-producing tissues in health and disease; *T. M. Sonneborn* and *W. J. van Wagtendonk*, Zoology Department, Indiana University, $6,500 for biochemical studies on the genetics of *Paramecium aurelia*; *Howard C. Taylor, Jr.* and *S. B. Gusberg*, Obstetrics and Gynecology Department, College of Physicians and Surgeons, Columbia University, $4,100 for histochemical studies of abnormal growth of the human uterus; *Sir Ernest L. Kennaway*, St. Bartholomew's Hospital, London, $1,500 for statistical and laboratory studies of cancer; *Edward W. Shrigley*, Microbiology Department, Indiana University Medical Center, $4,000 for studies on the biology of the Rous sarcoma virus and of the properties of experimentally induced tumors; *Frances L. Haven*, Biochemistry Department, University of Rochester School of Medicine and Dentistry, $3,000 for studies on the selective localization of radioactive estrogens and allied substances in normal and cancer-bearing tissues; *Rivka Ashbel*, Department of Surgery, Harvard Medical School, $2,500 for completion of a specific histochemical method for the demonstration of adrenal cortical ketosteroid; *Nathan B. Friedman*, Division of Laboratories, Cedars of Lebanon Hospital, Los Angeles, $2,735 for studies on cellular dynamics in intestinal mucosa as determined with antimitotic agents on animals of different age and nutritional status; *Joseph E. Sokal*, Department of Pathology, Yale University School of Medicine, under guidance of *C. N. H. Long* and *H. S. N. Greene*, $2.500 for the third year of his fellowship; *John J. Trentin*, Department of Anatomy, Yale University School of Medicine, under guidance of *William U. Gardner*, $4,400; *Walter S. McNutt*, University of Copenhagen, under guidance of *E. Hoff Jorgensen* and *H. Kalckar*, $3,000.

The Louis Edward Levy Medal of the Franklin Institute of Pennsylvania was awarded to Alan S. FitzGerald, electrical research engineer of San Francisco, for his work on the design criteria of nonelectronic amplifiers.

Colleges and Universities

The University of Michigan and the Mt. Wilson Observatory are cooperating in a solar research project whose immediate object is obtaining a complete record of the infrared spectrum, to be made available as an atlas for working astronomers. An infrared spectrometer, contributed for the purpose by the Office of Naval Research, has been installed on a solar telescope at the observatory. Two long range studies are also planned, to supplement and check solar observations at the university's McMath-Hulbert Observatory. One is a determination of the abundance, varieties, and temperatures of such compounds in the earth's atmosphere as carbon dioxide, nitrous oxide, and methane, and the other is a study of the structure of the solar atmosphere.

Wayne University, Detroit, will receive a differential analyzer and cinema integraph as a gift from the Massachusetts Institute of Technology. MIT is acquiring a machine of newer design, and will no longer need the earlier one, which was designed by Vannevar Bush before the war and has since been remodeled.

A new agricultural experiment station will be established at **Virginia Polytechnic Institute** as the result of a gift from Paul Mellon of a 420-acre farm and $125,000 for its operation. The station will be used to develop pasture and forage crops for northern Virginia.

Industrial Laboratories

The Linde Air Products Company, unit of Union Carbide and Carbon Corporation, has announced the synthesis of clear crystals of cadmium tungstate, which is being considered for use as a phosphor in scintillation counters for the detection of high energy radiations. This new tungstate maintains high phosphor efficiency throughout the temperature range of 0° to 75° C and has high physical and chemical stability. The synthetic crystals are now available in ¼-inch square section rods, in lengths up to 2 inches. In special cases larger single pieces can be supplied.

Eastman Kodak Company is producing photographic emulsions for nuclear research in pellicle form, without the usual glass support. In this form emulsions can be as thick as 250 microns and still be developed evenly because developing solutions work on both sides.

Meetings and Elections

Britain, which produces the largest amount of manufactured gas in the world, was appropriately the venue for the **4th International Gas Conference,** which was held June 15–17. The conference, organized by the International Gas Union, met for the first time since the war. An address of welcome was made by Hugh Gaitskell, Minister of Fuel and Power. President of the conference was C. M. Croft, of the British Institution of Gas Engineers, who retired toward the close of proceedings in favor of M. Brabant of Brussels, president of the union for the next three years.

Object of the International Union is the promotion of international cooperation in fuel research and technology. The organizers were glad to welcome delegates and visitors from Austria, Belgium, Canada, Czechoslovakia, Denmark, France, Great Britain, Holland, Italy, Norway, Sweden, Switzerland, Turkey, and the U. S. No curtain divides this body, which is essentially technical and not concerned with political or labor matters.

Principal themes were improvement of the efficiency of industrial gas manufacture and domestic utilization, which many countries reported to be the principal one. H. Zollikofer, general secretary of the Internation Gas Union and the Swiss Society of the Gas and Water Industry, pointed out, for instance, that in Switzerland about 80 percent of gas distributed is consumed domestically. Papers on the design of domestic burners were therefore a feature of the conference. There was also a valuable survey by A. R. Bennett of progress in the domestic utilization of gas brought about by radiation, heat transfer, and aerodynamic studies. Reviews of research in France, Britain, and the U. S. were presented. Two of the British papers discussed procedures adopted for maintaining gas supplies during bombing of mains.

There were three papers of chemical interest. J. E. Carrière, of Holland, discussed modern methods of protecting cast iron and steel pipes, including the use of blown asphalt bitumen with fillers. A project for absorption and recovery of carbon monoxide from town's gas was presented by H. Deringer of Winterthour. More elaborate was the paper by P. Ferrero of Belgium on the chemical ''valorization'' of coal gas to yield ethylene derivatives (notably glycols) by fractionating the original gas for its 2 percent of this valuable olefine.

Important among the many visits which contributed to the success of the meeting was a tour of the highly mechanized Beckton Gas Works, which consumes 1¼ million tons of coal and produces 22,600 million cubic feet of gas annually. Major gas consumers were also visited.

I. Berkovitch

The 19th International Congress of Americanists will be held in New York City September 5–12. The congress, which meets biennially, has as its objective the historic and scientific study of the two Americas and their inhabitants. The Viking Fund, Inc. is sponsoring the meetings and the American Anthropological Association is acting as principal host.

The Third National Congress of Fruit Growing will be held in Ferrara, Italy, October 9–16. Scientists and technicians throughout the world are invited to attend. Additional information may be obtained by writing to the Secretary of the Third National Congress of Fruit Growing, Foreign Section, Via Salita Castello 10, Ferrara, Italy.

The American Standards Association will hold its thirty-first annual meeting October 11–14 at the Waldorf-Astoria Hotel in New York.

The National Academy of Sciences will hold its autumn meeting at the University of Rochester, Rochester, New York, October 24–26.

The Seventh Annual Pittsburgh Conference on X-Ray and Electron Diffraction will be held November 7–8 at the Mellon Institute of Industrial Research, Pittsburgh.

The Illinois Institute of Technology chapter of Sigma Xi elected the following officers for 1949–50: president, Karl Menger of the Department of Mathematics; vice-president, Eric T. B. Gross of the Department of Electrical Engineering.

Deaths

John R. Carty, 56, former professor of radiology and chief of the X-Ray Department of the New York Hospital, Cornell Medical Center, died July 12. Dr. Carty had retired several years ago because of ill health.

Alfred Rehder, 85, professor emeritus of the Arnold Arboretum, Harvard University, died July 21. Dr. Rehder conducted research in the taxonomy and bibliography of woody and Chinese ligneous plants.

Archie Garfield Worthing, 68, professor of physics at the University of Pittsburgh, died July 30. Dr. Worthing had done considerable work in high temperature measurements and tungsten research. He was past president of the Optical Society of America and of the American Association of Physics Teachers, and a member of the executive board of the American Institute of Physics.

Hyman H. Goldsmith, 42, physicist and chief of the Information and Publication Divisions of the Brookhaven National Laboratory at Upton, Long Island, died August 7 as the result of a swimming accident. Dr. Goldsmith was formerly associated with the Manhattan District Project and was co-editor of the *Bulletin of the Atomic Scientists,* published by the Educational Foundation for Nuclear Research.

Edward Lee Thorndike, 74, professor emeritus of educational psychology at the Teachers College of

Columbia University, where he had been a staff member since 1899, died August 9 at his home in Montrose, New York. Dr. Thorndike was one of the first to devise tests for the measurement of reasoning and learning ability; his Alpha test, used in World War I, introduced the present Army classification system.

Homer Adkins, 57, professor of chemistry at the University of Wisconsin, died August 10 at his home in Madison. Professor Adkins' most recent research was concerned with reactions of hydrogen and organic compounds in the presence of various catalytic agents. Outside the field of catalysis he had contributed greatly to knowledge of the reactivity of a variety of organic types.

Science has received word that the **Peiping Union Medical College** is continuing its teaching and research program, unaffected by the change in government. The city was besieged for a period of six weeks in December and January and after skirmishes in the suburbs, the Chinese Communist army took possession of the city. There was no extensive destruction of property and only a small number of casualties in the municipal area. Municipal power and light were curtailed over this period; but the college maintains its own power plant, and during the siege classes continued without interruption. American staff members have remained at their posts.

Following the turnover, postal communication was interrupted for almost two months, but this has now been restored. Surface mails during the winter were greatly delayed and journals for the library for the past six months are just now being delivered.

The college was occupied by the Japanese military during World War II and the first postwar entering class in medicine was received in 1947. The rehabilitation program is about half accomplished; more departments are to be restaffed this year and additional wards in the hospital put into service.

Unesco proposes to publish later in the year a manual on the **international exchange of publications.** The manual will include an appendix containing a classified list of institutions, including libraries, universities, scientific institutions, learned societies, etc. throughout the world, which are willing to exchange either their own publications or other publications which they have regularly at their disposal. All institutions which have so far not sent to Unesco details of their exchange material in one form or another are urged immediately to communicate the following information to the Unesco Clearing House for Publications, 19 Avenue Kléber, Paris, 16e: (a) Name and full address of institution. (b) Exact titles of publications offered. (c) Institutions which wish to exchange their publications only under certain conditions are asked to state what these conditions are. Only information which reaches Unesco before *October 1st* can be used in the manual.

The Sectional Committee on Standardization of Optics of the American Standards Association recently held its second meeting. Subcommittees reported completion of proposed standards on nomenclature and specifications of color, and research on light sources. The committee is sponsored by the Optical Society of America.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has submitted the following list of wanted chemicals: pentamethylphenol, durenol, 8-chlorotheophylline, 2-amino-1,3,4-triazole, vanillyl amide (Δ^4-nonenoate), phosphonium bromide, 5-hydroxyuracil, perfluoroethylcyclohexane, vicine, myristicine, absinthin, 7-hydroxy-1-H-v-triazolo-(d)-pyrimidine, 7-(α)-12-(α)-dihydroxyprogesterone, 12-(α)-hydroxyprogesterone, bis-(2-(2′-fluoroethoxy)-ethoxy)-methane, xanthotoxin, sodium pregnanediol glucuronate, phloretin, hemipic acid, *p*-fluoroaniline, erythrophleine, and cyanogen.

An International Bibliography on Atomic Energy has been prepared by the Atomic Energy Commission group of the Department of Security Council Affairs of the United Nations Secretariat. Volume I, which is now available, is a selective bibliography of material on the political, scientific, and social aspects of atomic energy. Volume II, which will be published later this year, will discuss published scientific literature on atomic energy.

The 1947–48 ***Report of the Committee on the Measurement of Geologic Time*** has just been published. The report includes an obituary on Alfred Church Lane; a summary of the committee's activities during the year; a report from Arthur Holms, of the University of Edinburgh; an article on "The Necessity for Different Values for the Ratio Pb/V of the Crust and the Rest of the Planet," by Juan Manuel Lopez de Azcona (translated by A. H. and J. P. Marble); a review of work in Japan by Dr. Marble; "Archaeological Ages by Natural Radiocarbon Content," by W. F. Libby, with comments by R. F. Flint; "Preliminary Report on Determining the Age of Rocks by the Lead-Uranium Ratio of Zircon, Apatite, and Sphene from the Rocks Using Alpha Counting and Spectrographic Methods," by E. S. Larsen, Jr., N. B. Keevil, and H. C. Harrison; and an annotated bibliography of articles relating to the measurement of geologic time, compiled by Dr. Marble. The report may be obtained from the Division of Geology and Geography, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C., at $1.00 a copy.

Make Plans for—

Aeromedical Association, 20th annual convention, August 29–September 1, Statler Hotel, New York City.

American Mathematical Society, August 30–September 2, 55th summer meeting in conjunction with summer meetings of **Econometric Society**, **Institute of Mathematical Statistics**, and **Mathematical Association of America**, University of Colorado, Boulder.

American Psychological Association, September 6–10, Shirley Savoy Hotel, Denver, Colorado.

Selection and Eugenics

Curt Stern

Department of Zoology, University of California at Berkeley

When Charles Darwin pointed out the role that natural selection of certain genetic types has played in the evolution of animal and plant species, it was soon realized that modern man may be subjected to similar selective influences. As a result, two slightly different considerations were advanced, each complementary to the other. One dealt with the changes in natural selection that civilization has brought about. Darwin had stressed the ruthless struggle, in which the genetically less fit has a poorer chance of reproducing his kind than the more fit. Did not civilization reduce or eliminate this selection against the less fit by improving his chance of reproduction through charitable care, or artificial remedies? Had not an ominous situation been created which would lead to an increase in undesirable genetic constitutions? But to counteract this pessimistic view another possibility fired the imagination toward hopeful perspectives. Could not man take the genetic fate of the species into his own hands? Could he not be more efficient and successful than nature, and by the use of his knowledge improve the genetic qualities of future generations? Francis Galton coined the word *eugenics* to cover the whole "study of agencies under social control that may improve or impair the racial [meaning hereditary] qualities of future generations, either physically or mentally."

In accordance with its two aspects, the field of eugenics has often been subdivided into two branches, called negative and positive eugenics. The first is concerned with combating the increase or the presence of alleles or of genic combinations producing undesirable phenotypes, the second with furthering the increase of alleles or combinations causing desirable phenotypes, or at least guarding against the decrease of such genotypes.

The facts that eugenists use as a basis for the discussions are worthy of the most serious attention. While estimates of the frequencies of subnormal traits, physical or mental, are not very accurate, the total number of affected individuals in the United States amounts to many millions. Of course, only in some of these individuals are the subnormal conditions due to heredity causes, but the sum of genetically defective persons may well be much larger than one million.

It is customary in this connection to emphasize what it costs the public to care for defectives. Some decades ago, a number of studies were published of families who, in the course of generations, had contributed a large number of undesirable individuals to the population of the United States. The Jukes and the Kallikaks—literary names assigned to these families—became household words in the discussion of eugenic problems. The recurrence, generation after generation, of various types of criminality and of mental deficiency was taken as proof of the hereditary nature of these traits. It is now recognized that the methods used in gathering these family histories were highly uncritical and that these studies therefore give a distorted picture. Moreover, even if the data were unbiased no valid conclusions regarding the genetic component of the traits in these families can be drawn, since it is impossible to judge separately the parts played by genetic factors and by the very unfavorable environments which persisted generation after generation. As for the cost to society of these families, who instead of adding to its economy required support from it or were directly destructive to its assets, it was estimated as amounting over the years to millions of dollars. The significance of such sums, however, must be judged in terms of the total national expenditure. Although any unproductive expenditure is undesirable, the costs of caring for defectives are small relative to the sums involved in the whole economy.

It is often stated that physical defectives, and especially the "insane," are on the increase in Western nations. If this implies that the absolute numbers of such persons are increasing, this may well be so, since populations have also increased. A statement of this kind is meaningful only when it refers to the relative frequency of defectives in the population. When the facts are stated in relative terms it is indeed found that the relative number of patients *in institutions* has steadily increased, but the interpretation of these data is by no means obvious.

This rise may reflect a change in attitudes and in opportunities for social care. Whereas in former times the mentally ill were kept at home, they are now sent to hospitals. Better diagnosis and better methods of obtaining full reports also result in adding to the census of defectives. In Sweden, with its highly developed census system, 4,349 epileptic individuals had been registered in 1940. Medical examination of all Swedish men reaching the age for conscription, however, placed the total number of epileptics at about 12,000, indicating that the census had unearthed less than 40 percent of them. Apparently the accuracy of the census data depended on the willingness of people to divulge relevant information to the authorities. Dahlberg, to whom we owe this example, concluded that "there is plenty of room for an increased frequency through improved registration, even if the actual frequency of hereditary epilepsy were to decrease appreciably" (*1*).

One more factor may be mentioned that enters into an interpretation of increased frequencies of certain defects. Many pathological conditions, among them certain types of mental derangement, as well as organic diseases like cancer and diabetes mellitus, tend to make their appearance in the later periods of life. Without the recent prolongation of man's average life span, many persons who now reach an older age and become affected formerly would not have lived to the necessary age and would not have swelled the number of recognized defectives.

TABLE 1

RATIO OF THE NET REPRODUCTIVE RATE FOR SPECIFIC URBAN CLASSES TO THE CORRESPONDING RATE FOR THE TOTAL URBAN WHITE POPULATION OF THE UNITED STATES, 1935–1936*

Education of mother	Reproductive ratio
College	0.74
High school	0.97
Seventh or eighth grade	1.23
Less than seventh grade	1.39

* After Karpinos and Kiser (2).

The greatest concern expressed by eugenists is that the intellectual genetic endowment of Western populations is in danger of decreasing. This fear is based on the fact of differential fertility. If, for instance, the population of the United States is subdivided into different categories, according to occupation, educational background, income, or in other ways, it is found that the average number of children per family is different for the different groups. The striking fact regarding the average reproduction of the different categories is that it decreases with increase in socioeconomic status, as shown in Table 1.

The differential fertilities of groups of different socioeconomic status are of no concern to the geneticist if the genetic endowments of the different layers of the population are alike—that is, by and large, if the same allele frequencies for all loci hold for the different groups. If, on the other hand, different layers differ in their corporate genetic make-up, then differential reproduction constitutes a selective agent.

We cannot say now with any certainty whether or not different socioeconomic groups are genetically differentiated. The difficulties of research in this important field are great. The concept of socioeconomic levels itself is subject to various definitions, involving occupation, social prestige, amount of income, education, etc., and a simple scale of levels does not represent actualities satisfactorily. These, however, are minor difficulties as compared to finding out whether different groups are or are not genetically alike. It might be not too difficult to obtain data on this problem as related to various physical traits. But the question is primarily concerned with mental traits, since these may possibly be correlated with the socioeconomic status of the individuals. Mental traits are expressed very differently, according to environmental conditions—in the widest sense of the term environment. Undoubtedly, a large part of the variability in mental traits among human beings of different levels is therefore attributable to differences connected with their being in different environments as represented by these levels. Psychological tests which measure mental differences are imperfect indicators of the genetic nature of such differences, since psychologists have not fully succeeded in devising tests that are equally intelligible to individuals who have grown up in different social surroundings. Even with these imperfections of the tests in mind, however, there is evidence that strongly suggests hereditary influences.

TABLE 2

AVERAGE I.Q. IN THE CHILDREN (18–54 MONTHS OLD) OF FATHERS OF DIFFERENT OCCUPATIONAL LEVELS IN THE UNITED STATES*

Occupation of fathers	Average I.Q.
Professional	125
Business, clerical	120
Skilled workers	113
Semiskilled workers	108
Unskilled workers	96

* After Goodenough (4).

Intelligence tests of the children of parents belonging to different socioeconomic levels show a rather consistent phenomenon, whether, for instance, based on studies made in the United States (Table 2), or in Soviet Russia (Fig. 1). The mean scores decline consistently from groups of higher levels to those of lower levels. How much of this decrease is environmentally conditioned is difficult to evaluate. Various lines of evidence, however, particularly studies on twins reared together as compared with others separated early in life, and on the intelligence scores of adopted children in relation to occupational status of the foster father and as compared with own children, make it hard to avoid the conclusion that environment is not the sole agent and that there *are* mean differences in the genetic endowment of different socioeconomic groups.

At each level scores vary greatly, much more than do the mean scores of the different levels. The result of this intragroup variability is that an individual from a high level with a score at the average of his group will be surpassed by a great many individuals from a lower level; and, conversely, that an individual from a lower level with an average score for his group will be superior to many individuals of a higher level. The fact that there is a wide spread in I.Q. scores within each group mirrors to some extent the fact that different homes provide very different environments. Undoubtedly the spread in I.Q. scores is also owing to hereditary differences which express themselves in varying capabilities even within a single socioeconomic group.

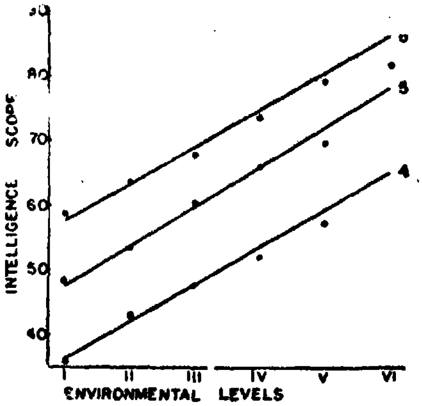

FIG. 1. Mean scores in intelligence tests administered in Charkow (USSR) to pupils in grades 4, 5, and 6, according to environmental levels as judged by parental education. Environment I applies to children of workers, one or both of whom were illiterate, VI children of officials who had university education (5).

Investigations restricted to the subnormal categories of intelligence point to the same conclusion. It was found in several studies that the relative frequency of feeble-minded children was considerably higher in the lower socioeconomic groups than in the upper ones. Thus the lower average I.Q. scores of the lower levels is in correlation with the greater frequency of *very* low I.Q. scores among the children. This correlation undoubtedly has an environmental component in that the restrictions of a lower socioeconomic status tend to relegate a child of low intellectual potentiality to the feeble-minded group whereas the opportunities provided by a higher status would tend to shift the same child into the range of better I.Q.'s. It seems unlikely, however, that such environmental factors are solely responsible for the high rate of feeble-minded children in the lower levels. It is more likely that the segregation of genetic constitutions involved in low I.Q. scores in the parents results not infrequently in genotypes among the children that place them in the range of feeble-mindedness. Probably, too, expression of genetic constitutions involved in low scores may vary from feeble-mindedness on up and the same genotype that in a parent permits somewhat higher intelligence may produce some feeble-minded children.

To reach the conclusion that there are probably genetic differences in intellectual endowment of the different socioeconomic levels is one thing, but to determine the specific type and magnitude of these differences is quite another. Undoubtedly, the differences are not absolute in the sense that any layer of a population is in the exclusive possession of alleles effective in the control of intelligence. There are no sharp boundaries between layers, since many individuals in each generation rise from a lower to a higher status, while others fall from a higher to a lower status. Some of these shifts may be explained by genetic segregation—of better genotypes in the lower levels and of poorer genotypes in the upper levels—but even if this interpretation should be true, there is a lag brought about by environment that keeps many with higher genetic endowment from rising and others with lower endowment from falling.

Whatever the genetic details and however important they may be for a complete insight, one fact is already apparent: If there are genetic differences between different socioeconomic layers, then differential fertility will result in selective increase of some allele frequencies, and decrease of others in the population as a whole. Since the differential fertility acts in favor of high reproduction of the intellectually more poorly endowed groups, and against high reproduction of the bettter endowed groups, a deterioration of the genetic endowment of the population should result.

The degree of this deterioration from one generation to the next could be determined only on the basis of exact data on the genetic basis of the intelligence scores and their nature-nurture interdependence. Lacking such data, attempts have been made to calculate expected phenotypic changes—that is, in the I.Q. scores—in successive generations. Using the observed mean scores in different socioeconomic levels and the observed reproductive values of these levels, various authors have arrived at estimates for the decrease in I.Q. for the population as a whole, from the present generation to the next. These estimates vary from about one to around five points. The calculations are based on many uncertainties and cannot be checked with observation, since no actual tests of successive generations have yet been made.

Historically, differential reproduction, on a large scale, of the type under discussion is a rather recent phenomenon. It is primarily the result of birth control, which became an important social practice in the second half of the 19th century. Since birth control measures are more frequently used by the upper and middle groups of Western countries than by the lower ones, the limitation of births becomes a selective process. There is reason to believe that the use of contraceptive measures will spread over the population as a whole and that the differential in the fertility of different groups will be diminished. From a eugenic point of view such a result is desirable.

There is a possibility that the differential fertility of the different groups is less significant even now than it appears. Some data indicate that the most successful members of the upper groups (success being estimated in various ways) are more fertile than the less successful ones. The reasons for this higher fertility may be related at least partially to the favorable financial status of these successful families, which permits them to bring up children under good conditions without undue strain. If the relatively high fertility of the upper subgroups within the higher levels should be a general phenomenon, and if success *within* a group is positively correlated with intellectual genetic endowment, then the higher fertility of the most successful would counteract, to an unknown degree, the low fertility of the group as a whole.

No studies have been made which give information on the fertility of different subgroups within the middle or lower groups. It does not seem unlikely that here the correlation between success and fertility is again negative. In the upper subgroups of the lower or middle groups, with their relatively small financial resources, the desire to provide for one's children the most favorable conditions may lead to particularly stringent birth limitation.

It is likely, then, that the present differential fertility of the different groups has a dysgenic effect in regard to intelligence. But the question may be raised whether there are desirable mental traits under gene control whose frequencies may be positively correlated with fertility. The upper layers of Western societies apparently have a relatively high frequency of genetic constitutions favoring intelligence, but they seem to be no better off than other strata in their frequency of alleles which lead to idiocy. Could there be still a third type of genetically controlled mental traits for which the upper groups are relatively deficient, but which constitute assets to the individual and to society? An answer to this question cannot be given. It would depend on many factors, of which only a few may be mentioned. The first difficulty arises in defining a desirable trait. Emotional stability might be desirable, but it is a trait that does not accompany many types of genius which enrich civilization. Altruism may be another desirable trait, but acquisitiveness and egocentric ambition have not produced misery exclusively but have also led to advances which have contributed to the welfare of the masses. It will be hard to agree on definitions of desirable traits—and it is clear that the ideal does not lie in uniformity.

Even if some agreement could be reached, a second difficulty is that measures of the genetic component of men's variability in regard to these traits are not available. The social plasticity of mankind is very great and different societies and groups within societies mold the attitudes of their members in most diverse ways. Many facts of psychology show that cooperativeness or aggressiveness can be produced by environmental influences acting on the same individuals, but these facts do not preclude the possibility that certain genetic components, yet unknown, may bring out one particular trait more readily than certain others.

There is some relevant evidence from two genetically different strains of laboratory mice. Under certain conditions, the males of one strain react peaceably to a strange mouse and the males of the other strain are highly aggressive. Yet within a few days specific training can transform both types of mice into either peaceful or fiercely fighting individuals.

We have stressed the tentative nature, and the frequent absence, of knowledge regarding the genetic basis of differences among human beings. Even if the information were more complete we would still have to make a detailed investigation of the effects selective agents would have on the genetic and phenotypic composition of later generations, before we could fully understand the dynamics of populations. A few theoretical situations will be discussed in which selection for or against various genotypes is active.

The simplest situation is that of selection against a single factor, autosomal dominant genotype *DD* or *Dd*, or conversely, selection for a recessive genotype *dd*. Practically all persons carrying a rare dominant allele are heterozygous, so that we may restrict our discussion to a population consisting of only *Dd* and *dd* individuals. If the dominant allele is fully penetrant and causes its phenotypic effect to appear before the reproductive age has been reached, then suppression of reproduction of all affected individuals will lead to elimination of the dominant condition from the next generation (Fig. 2, dotted line) except for new mutations from the recessive to the dominant allele. If, on the other hand, selection, in terms of suppression of reproduction of *Dd* individuals, acts only on some

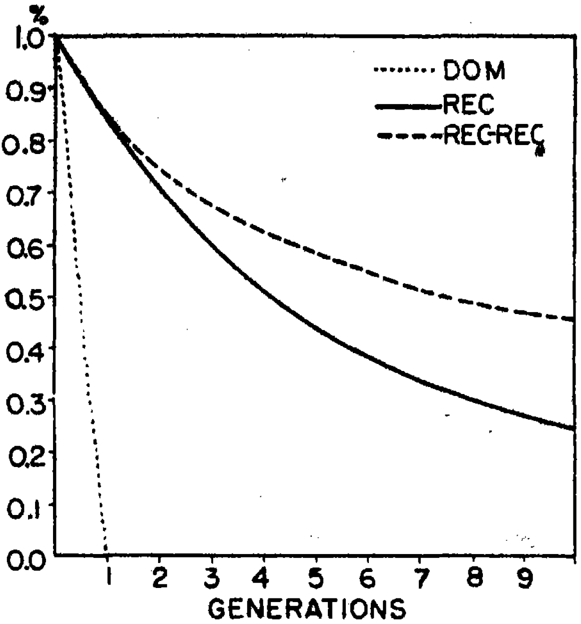

FIG. 2

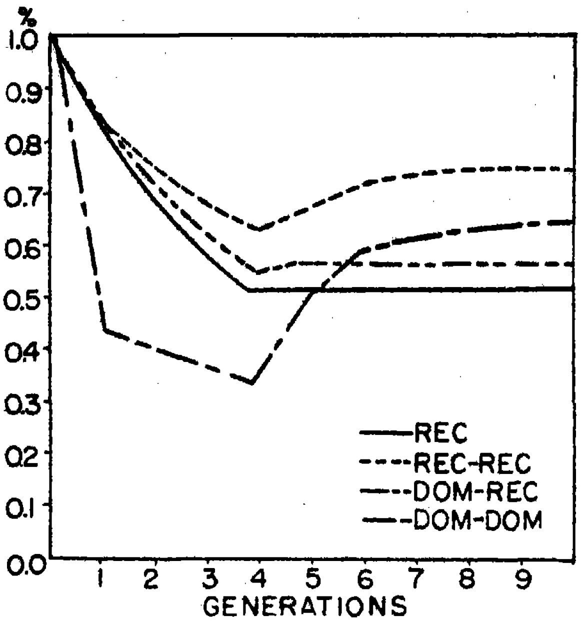

FIG. 3

FIG. 2. Complete selection for ten successive generations against a rare dominant genotype (Dom), a recessive (Rec), and a double homozygote (Rec-Rec). Initial frequency of the selected genotypes 1% (3).

FIG. 3. Complete selection against certain genotypes for four successive generations and cessation of selection during the following six generations. Rec = homozygous recessives; Rec-Rec = double homozygotes (e.g. $A^2A^2B^2B^2$); Dom-Rec = dominant phenotype in regard to one pair of alleles, recessive in regard to a second pair (e.g. *AAbb* and *Aabb*); Dom-Dom = dominant phenotype in regard to two pairs (e.g. *AABB*, *AaBB*, *AABb* and *AaBb*) (3).

and not on all these individuals, either because penetrance is incomplete or for other reasons, then a fraction of affected persons will reappear in successive generations. If, for instance, half of the carriers of a dominant allele are selected against, while the other half reproduce at the rate of the genetically normal population, the number of carrier individuals will be reduced to one-half in the first generation following selection, to one-quarter in the second, and in general to $(\frac{1}{2})^n$ of the original number where n equals the number of generations.

Complete selection against a single dominant factor is thus 100 percent effective in a single generation, and even partial selection accomplishes much. For example, with a selection factor of one-half, the number of dominants is reduced to a little more than one-tenth of the original number in three generations, and has practically disappeared in ten generations. If, for instance, all dominant chondrodystrophic dwarfs, or all individuals with dominant juvenile cataract would not reproduce, then the unhappiness caused by the birth of affected individuals in these families would be completely eliminated in one generation. For dominantly inherited diseases like Huntington's chorea, which often sets in after the reproductive age has begun, the reproduction of the disease through cessation of procreation by phenotypically affected persons will follow the experimental decrease.

Even with incomplete penetrance of a dominant allele, a complete elimination in one generation could be accomplished if *all* children who had an affected parent remained childless, regardless of whether they were phenotypically healthy or affected. This would involve not only the *Dd* individuals who might later become diseased, but also their *dd* sibs who are genetically normal. Such a situation is fraught with tragedy. A person who knows that he is the carrier of a genotype that leads to a very serious disease later in life will undoubtedly not wish to risk the chance of producing potentially affected children, but the personal sacrifice in remaining childless will appear very heavy if the potential parent finds out later in life that he was free from the dreaded allele. A means of distinguishing between *Dd* and *dd* individuals when both are still normal would be of great benefit to such people.

Selection against a single-factor, homozygous, autosomal genotype *dd*, or conversely, selection for a dominant *DD* or *Dd*, is less effective than the type of selection just discussed. The decrease of *dd* individuals from one generation to the next in a population in which all *dd* adults have been excluded from procreation can be calculated on the basis of the known frequencies of the alleles *D* and *d*. If the two frequencies are p and q respectively $(p+q=1)$, then the frequencies of the three genotypes *DD*, *Dd*, and *dd* in the original population are p^2, $2pq$, and q^2. After complete selection against *dd*, new *dd* can be produced only in $Dd \times Dd$ unions. The frequency of *Dd* in the total population is $2pq$. Since under complete selection against *dd* only *DD* (p^2) and *Dd* ($2pq$) contribute to the next generation, the relevant frequency of *Dd* among the *fertile* population is

$$\frac{2pq}{p^2+2pq} = \frac{2q}{p+2q}$$

which, because $p = 1 - q$, becomes

$$\frac{2q}{1+q}.$$

Therefore the frequency of *dd* in the new generation as a result of marriages of $Dd \times Dd$, amounts to

$$(q_1)^2 = \frac{1}{4.} \cdot \left(\frac{2q}{1+q}\right)^2 = \frac{q^2}{(1+q)^2} \qquad (1)$$

The significance of the formula becomes apparent if some specific values for the initial frequency, q^2, of *dd* individuals are used. If, for instance, this frequency is 1 percent then, after one generation of complete selection against the affected individuals $(q_1)^2$ amounts to 0.83 percent. If the initial frequency is 0.83 percent, selection in one generation will reduce it to 0.69 percent; if the initial frequency is 0.01 percent the reduction will lead to 0.009803 percent.

These figures show two main facts: (1) that the lowering of the frequency is only a fraction of any initial frequency and (2) that the relative efficiency of selection against recessives lessens with a decrease of the initial frequency. The second point is well illustrated by a comparison between the first and last examples. The reduction from 1 to 0.83 percent represents a lowering of the initial frequency of *dd* by 17 percent, while the reduction from 0.01 to 0.009803 percent represents a lowering by only 2 percent.

This decrease in the effectiveness of selection against recessives with a lowering of the initial frequency is of great significance if one considers the results expected from selection continued over many successive generations. In Fig. 2 (continuous line) the results of selection over ten generations are given, starting with an initial frequency of 1 percent. It can be seen that the reduction in frequency of *dd* becomes less in each successive generation and that, after ten consecutive generations of total selection, it is still nearly one-quarter of the initial frequency of 1 percent. To reduce it to one-tenth, that is 0.1 percent, would require 22 generations. If the selection against recessives is not complete but reduces the average reproduction of *dd* individuals to some fraction of the normal rate, then obviously the effect of the selective process is even less.

Selection would be more effective if it included not only the homozygotes themselves but also certain of their close relatives who are likely to be heterozygotes. The immediate effect, however, would be very small, since in the case of rare alleles most marriages of heterozygous persons are with homozygous normal ones. It is true, nevertheless, that for any two heterozygotes who do not reproduce, two recessive alleles are eliminated, and this elimination, on the average, is equivalent to the nonappearance at some future time of one affected person.

The foregoing analyses of the effect of selection against simple dominant or recessive traits apply primarily to specific abnormal traits. From a general point of view, the significance of these traits is small if compared to such traits as intelligence, for which a whole series of expressions exists and which are rightly of greater concern to the student of human genetics and to the sociologist. These quantitatively varying traits, insofar as their variation is genetically conditioned, are the results of expression of *multifactor genotypes*. If, for instance, a trait is controlled by two pairs of genes A^1, A^2 and B^1, B^2, then nine different genotypes may be present in the population: $A^1A^1B^1B^1$, $A^1A^2B^1B^1$, $A^1A^1B^1B^2$, $A^2A^2B^1B^1$, $A^1A^1B^2B^2$, $A^1A^2B^1B^2$, $A^2A^2B^1B^2$, $A^1A^2B^2B^2$, and $A^2A^2B^2B^2$. If $A^1A^1B^1B^1$ and $A^2A^2B^2B^2$ are phenotypical extremes—for example, if they represent the lowest and highest endowment in the population—and if every substitution of A^2 for A^1, or of B^2 for B^1 increases the endowment to a certain degree, then nine different degrees of endowment will exist.

The results of selection against one or more of these multifactor phenotypes are different from those against single-factor genotypes. This may be seen in Fig. 2 (broken line), which shows the decrease of $A^2A^2B^2B^2$ individuals during ten consecutive generations of complete selection against this type. From an assumed initial frequency of 1 percent the frequency drops after one generation to 0.83 percent—just as in selection against a single-factor type *dd*. However, in later generations the decrease of $A^2A^2B^2B^2$ is much less than of *dd*. After ten generations the $A^2A^2B^2B^2$ class still recurs in 45.5 percent of its initial frequency, in contrast to 25 percent of the *dd* class. The slower progress in the transformation of a population in case of multifactor as opposed to single-factor inheritance is owing to the fact that the populations contain different frequencies of carrier individuals. In single-factor inheritance only the heterozygous *Dd* individuals form a reservoir from which a *dd may* be reconstituted. In two-factor inheritance against $A^2A^2B^2B^2$ *all* genotypes except $A^1A^1B^1B^1$ are carriers for one or the other, or for both of the alleles A^2 and B^2 against whom selection is directed. In a population which contains 1 percent *dd*, 18 percent are *Dd* carriers; but in a population which contains 1 percent $A^2A^2B^2B^2$, 77.1 percent are $A^1A^2B^1B^1$, $A^1A^1B^1B^2$, $A^2A^2B^1B^1$, $A^1A^1B^2B^2$, $A^1A^2B^1B^2$, $A^2A^2B^1B^2$, or $A^1A^2B^2B^2$.

In single-factor inheritance with random mating, a change in an allelic frequency as a result of selection immediately leads to the establishment of a new constant distribution of the three genotypes *DD, Dd,* and *dd.* This is an expression of the Hardy-Weinberg rule, $p^2\ DD : 2\ pq\ Dd : q^2\ dd$. This immediate establishment of an equilibrium implies that a lower frequency of *dd* attained after selection will remain at its level after selection ceases. It was Weinberg himself, however, who realized soon after his discovery of the situation relating to one gene pair, that for multiple pairs, if the equilibrium were disturbed, a new equilibrium would be established only gradually. This may be shown for the $A^2A^2B^2B^2$ class. After one generation of selection this class is reduced from an initial frequency of 1 percent to 0.83 percent. If selection is discontinued, reconstitution of the class from the large reservoir of carrier individuals leads to a new rise, which gradually brings its frequency up to 0.91 percent—that is, to a recovery of nearly one-half of the originally lost frequency.

This "comeback" phenomenon in two-factor pair inheritance is obviously not restricted to cases in which selection ceased after one generation. Fig. 3 shows its existence and extent for some other examples, giving the changes in the frequencies of various phenotypes after complete selection had acted for four generations and then ceased.

Multifactor inheritance is usually based on many more than two pairs of factors. The foregoing discussions, modified, apply also to inheritance involving three or more pairs. Since in a population the frequency of individuals who are carriers for at least one of the alleles concerned in selection increases with the number of loci, the speed with which selection permanently accomplishes specific results decreases with increasing number of loci.

The numerical data presented for selected cases of multifactor inheritance are examples of the kind of information needed for a detailed understanding of the effect of differential fertility in man upon the phenotypic and genotypic composition of later generations. The model examples used in our discussion cannot be regarded as representing adequately the still unknown genetic situation in respect to such traits as performance in intelligence tests, or other genetic components believed to participate in the variability that places different individuals into different socio-economic layers. It already seems possible, however, to say that genetic changes brought about by selective agents are small from one generation to the next, and that the effectiveness of selection cannot be judged solely from a consideration of immediate phenotypic changes.

The effectiveness of selection has been discussed for populations which at the beginning of the selective processes were in equilibrium. Specific alleles or combinations of alleles, however, frequently occur in relatively high concentration in "pockets" of the population. The efficiency of selection is *increased* if there is a relatively high concentration of alleles in isolates, or more than random frequencies of homozygotes or of selected multifactor combinations.

In another respect the effectiveness of selection may often be *lower* than predicted at first. If an inherited trait has a certain frequency in a random mating population it must be ascertained whether the appearance of the trait is due to alleles at the same locus in each affected individual or whether it may be caused by different loci. If the trait is the result of two or more different genotypes based on different loci, then the effect of selection has to be considered separately for each genotype.

This may be shown by an example. Assume a population in which 1 in 10,000 individuals is blind for genetic reasons—that is, a frequency of 0.0001. If the blindness of all individuals were caused by the same homozygous recessive allele, then one generation of selection against the trait, according to equation 1, would reduce its incidence to 0.00009803. On the other hand, if there were ten different, and equally numerous genotypes, each of which produces blindness, then the initial frequency of any one of them would be one-tenth of 0.0001 or 0.00001. Selection, for one generation against each homozygous genotype, would reduce it to 0.000009937, so that the frequency of the sum of all individuals affected with any one of the ten genotypes is 0.00009937. Selection against the trait would thus lead to a reduction of only 0.63 percent of the original frequency as compared to 1.97 percent when a single genotype is involved. This hypothetical example is probably representative of many actual situations, since many results suggest that similar or apparently identical hereditary phenotypes are the result of diverse genetic constitutions.

The slowness of selective processes against recessive single factors and against multiple factors is both a blessing and a curse. It is a fortunate feature in that it forms a powerful buffer against sizable, undesirable effects of selection, as in differential fertility directed against intellectually well-endowed groups. It is an unfortunate feature in that selective measures aimed at eliminating undesirable traits are rendered relatively ineffective. In either respect the population at large serves as a huge reservoir for alleles from which the desirable and undesirable genotypes can be reconstituted.

If the hopes and fears of the eugenic movement seem greatly exaggerated in the light of a numerical treatment of the problems, it should not be forgotten that the idealism which concerns itself with the genetic fate of future generations has a sound core. To say that the loss of supposedly desirable genotypes in one or even many generations of differential fertility is small does not remove the fact that it *is* a loss, which may be regrettable and possibly even have serious consequences. Although reproductive selection against severe physical and mental abnormalities will reduce the number of the affected from one generation to the next by only a few percent, nevertheless these few percent may mean tens of thousands of unfortunate individuals who should not be born. Conversely, even a slight increase of desirable genotypes, through positive eugenic measures, would be a social gain.

Eugenic and dysgenic selection are concerned with genetic constitutions which under present physical, mental, and social circumstances may lead to desirable or undesirable phenotypes. Since many genotypes express themselves differently under different environmental conditions it is possible that new kinds of environments can make genotypes which now lead to undesirable phenotypes shift their developmental reactions so as to result in desirable phenotypes. Thus, if a certain genotype formerly caused the serious disease diabetes mellitus, by way of a deficiency in internally produced insulin, the same genotype can now be made compatible with nearly normal living, by means of injection with insulin. Or it may be assumed that one genotype gives its carriers, in their specific educational and social environment, a lower I.Q. than another genotype gives to other individuals in their different environment. In spite of these circumstances, it might be possible to bring the carriers of the "lower" genotype to the same high achievement or even higher than the others, by means of a particularly appropriate environment.

Does substitution of a special environment to make up for deficient gene function necessarily lead to a weakened constitution of mankind? This question is frequently asked, and if it means that man may become more dependent on his environment than he was when all deficient genotypes were wiped out by natural selection the answer is yes, as far as the specific trait is concerned. Such dependence on special environments, however, did not start with the advent of civilization. When, in earliest evolutionary times, animals first developed, a new dependence of organisms on the environment arose. Instead of being able to synthesize their protoplasm from inorganic sources, animals had to rely on other organisms for food. When, much later, man's ancestors lost most of their mammalian body hair another, but this time minor, step was taken. Man had to rely on fur from other mammals and on fire to keep his temperature at the necessary physiological level.

In no instance, however, has man's greater dependence on specific outside sources for his survival been equivalent to degeneration. On the contrary, the dependence has often resulted in greater freedom from the restrictions of the external world. The loss of ability to use inorganic material for food became correlated with the evolution of nervous systems and sense organs, which make possible the many autonomous adjustments of animals. The dependence on clothing and fire enabled man to occupy regions of the globe where he could not have survived earlier. The passing of the primitive stages, in which each man was to a large extent independent of the help of others, gave rise to the complex interdependence of men in modern civilization. This new dependence has released man from the physical and mental starvation of earlier times. It is true, however, that man's freedom from his many limitations can persist and grow only if he retains and extends his slowly acquired control over his environment and over himself.

Human genetics concerns our own as well as future generations. Genetic counseling is largely devoted to individual problems, but the social implications of specific advice usually have not been disregarded. Eugenic thinking has always emphasized the well-being of mankind, even though much eugenic counseling was based on inadequate knowledge and has been harmful. In the future more knowledge will be gathered and will aid wise planning. Then genetic and eugenic counseling will become the foundation of human genetic engineering. Although eugenic problems are not as urgent as the pessimists believed, their ultimate importance can hardly be overestimated.

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This article is a condensed version of the chapter on selection and eugenics in Dr. Stern's forthcoming book, **Principles of human genetics**, *to be published by W. H. Freeman and Company in September.*

Research Publication: A Federal Responsibility?

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"THE NATION'S POSTWAR BUDGET for research and development during 1947 reached the highest point in our history—more than $1.1 billion." Thus John R. Steelman reports to President Truman in "Science and Public Policy" on the unprecedented volume of our national research effort (*2*).

This is a staggering figure when viewed against a total national research expenditure in 1930 of $166 million and of $345 million in 1940. Over a period of 17 years the national budget for research and development has increased more than 560 percent. Steelman recommends further that "our national expenditures for research and development should increase as rapidly as possible. By 1957, we should have at least doubled our present budget for this purpose" (*3*).

If Steelman were making his report today, he would have the federal expenditures on atomic energy research and development to add to the total. Officials of the Atomic Energy Commission estimate that approximately 300 million dollars of their federal appropriation are now spent annually on scientific research, exclusive of construction, weapon development, and administrative costs. This raises the total annual national expenditure for research and development to well over the billion dollar mark.

RESEARCH VS. PUBLICATION

For the cause of science, this calls for rejoicing. But something has been overlooked. The scientific journals—in which results of this tremendous research effort would normally be published—have not kept up either in volume or in scope with the increase in research. On the contrary, these journals have been beset by rising printing costs and overtaxed by the amount of good scientific material crying to be published.

To make matters very much worse, most research expenditures are made by the federal government and publication in the government, by tradition, has been viewed rather dimly because Congress frowns on publicity by government agencies. Although scientific publication is a necessary part of research and a far cry from publicity, the bad connotation of publishing by the government persists. This is unfortunate, for science rests upon its published record, and this record is of the utmost importance.

ONR-AEC POLICY

It is interesting to note the stand taken in this respect by two government agencies which today figure most importantly in scientific research—the Office of Naval Research and the Atomic Energy Commission. ONR's publication policy has been stated as follows: "The most appropriate means of disseminating results of sponsored research is by publication in the recognized scientific channels." The AEC, in its Fifth Semiannual Report, says: "The Commission's policy is to encourage the use of normal channels for the release of scientific and technical information" (*8*). Both agencies have adopted this policy because they believe the normal channels for scientific publication have been tested by time and found acceptable. But the policy has now proved inadequate.

Let us review effects of this policy. The Royal Society Scientific Information Conference, held in London last sumer to examine the scientific publication problem on an international scale, listed these major effects of the existing publication system of scientific papers:

1. *Absolute loss of knowledge.* Many papers are never seen by the workers who could make use of their findings and who are therefore obliged to discover the results for themselves.

2. *Relative loss of knowledge.* Owing to delays in publication, abstracting and distribution, scientific papers often reach interested workers long after their publication, occasionally as long as three years. This delay slows down the whole circulation of science and also leads to unnecessary duplication.

3. *Inconvenience,* due to loss of research time in searching for literature and for this purpose reading through masses of irrelevant information.

4. *Increasing cost of publication,* which in turn has three consequences:

   a. Reducing the possibility of full publication of scientific material

   b. Crippling scientific societies by so adding to their subscriptions that they lose membership, and consequently

   c. Depriving the students of poorer finances of the possibility of membership of these societies.

5. *Loss of scientific, clerical, and technical manpower* in directing and administering an extremely complicated

and overlapping series of small undertakings producing scientific literature.

The report concludes that "these obstructions to scientific progress are plain and obvious" (*5*).

These, then, are some of the recognized universal effects of the existing system of scientific publication. ONR and AEC, in recommending use of this system, as it now exists, are recommending use of an inadequate system, but are severely limited in authority and resources to make it more adequate. At the same time they are burdening the scientific press by adding to the volume of papers it must handle.

To illustrate specifically what is happening to the normal channels for scientific publication, let us examine journals in two very important fields: physics and the biological sciences.

Physics. The American Institute of Physics publishes the following journals: *Physical Review, Reviews of Modern Physics, Journal of the Optical Society of America, Journal of the Acoustical Society of America, American Journal of Physics, Review of Scientific Instruments, Journal of Chemical Physics,* and *Journal of Applied Physics.* The first five are published by the Institute for member societies and the last three are the property of the Institute. About a year ago the Institute started a semitechnical publication, *Physics Today.*

The Institute is trying to cope with its increased publication costs by using a standardized format for all of its eight technical journals, by lowering typographical standards somewhat, and by expecting authors (or their laboratories) to make an appreciable contribution towards the cost of publication. Such aid is asked on the grounds that this cost is small compared with that of the research described, and that it encourages brevity of presentation. This policy is implemented by giving no free reprints and by charging a high price for any number up to 150. Price of reprints ranges from $11.90 for 150 reprints of articles of 1–4 pages to $59.50 for an article of 17–20 pages. An additional $7.50 is charged for covers. Alternatively, authors may elect to pay a publication charge of $4 per page. In this case they are entitled to 100 "free" reprints (without covers), and the price of further copies is then obtained by deducting that of the first 100 from the prices quoted above. In practice, the latter option is decidedly more expensive for the author. It is nevertheless the one that he is expected normally to adopt as a means of meeting part of the costs of publication.

The authors are also expected to prepare any diagrams included with the paper in a form suitable for immediate publication. The American Institute of Physics offers no facilities for redrawing. Poor diagrams are returned to the authors, and the result is delay of publication.

The author is expected not to make changes after his article has reached the galley proof stage, and is charged $3 per hour for editorial corrections.

In spite of these restrictions, physicists are publishing at an increasing rate. Henry A. Barton, director of the American Institute of Physics, reporting on the financial difficulties of the *Journal of Chemical Physics,* says: "The budget was balanced in 1948 only by 'holding over' some 200 pages ready for publication . . . to catch up and keep up with the accelerated flow of material meeting the editorial standards of the Journal, 2000 pages are needed for 1949." In 1944, 596 pages had been adequate.

Dr. Barton continues: "The estimated total income of the Journal for 1949 is $30,000, which falls $20,000 short of providing for the demand. . . . To meet the need of the *Journal of Chemical Physics* and others of a like nature, the Institute would have to budget such large deficits as to exhaust its total financial reserves in eighteen months. Obviously a more durable solution must be found. Meanwhile the Executive Committee of the Institute must very reluctantly restrict the page budget for 1949 to a figure much lower than 2000. . . . It is hard to overstate the seriousness of the present situation" (*1*).

How much of all this should be of concern to the government? A count of all articles and letters-to-the-editor appearing in the *Physical Review* over a six-month period last year revealed that fully a third were reports on government-sponsored research. There is no way of estimating what percentage of government research papers go unpublished, but the journal's many-month backlog indicates that very many such papers are lying in the editor's basket.

Furthermore, the rise of nuclear physics has created special needs and no journal has come into being to provide for them. For instance, as far as ONR and AEC are concerned, there is no "normal" publication channel for the hundreds of nuclear physicists working on their programs. If results in this field are published they add to the burden of the present physics journals.

Nuclear physicists have an alternative: they can and do publish in McGraw-Hill's semitechnical magazine *Nucleonics.* It provides only limited publishing facilities but it fills, in a marginal way, a need that commercial backing can fill where a less favorable financial position prevents the nonprofit Institute of Physics from attending adequately to many of the scientists it was founded to serve.

Biological sciences. The situation as regards publication in the biological sciences is at least as serious as in physics. For one thing, the research men in the biological sciences have not been organized until very recently. The American Institute of Biological Sciences was started just a year ago to serve this important group of scientists, whereas the American Institute of Physics was founded in 1931.

This looseness of organization has led to confusion. A count made recently by the American Institute of Biological Sciences reveals that there are in existence some forty journals in this field, some with a circulation of only two hundred. To mention just a few, there are the *American Journal of Physiology, Journal of General Physiology, Plant Physiology, Ecology, Ecological Monographs, Phytopathology, Journal of Parasitology, American Biology Teacher, Journal of Bacteriology, Bacteriological Reviews,* the *Bryologist, American Journal of Botany, Copeia, Journal of Heredity, Growth, Transactions of American Entomological Society, Journal of Economic Entomology, Entomological News.*

It would be difficult indeed to establish which are the normal channels for publication here. Many of the journals seem to overlap in function and field covered. Many reach such a limited audience that it would seem they hardly justify their publication costs. It is little wonder that publishers of most journals in the biological sciences are worried.

And yet the biologists constitute a large group that must be served. Seventeen member and affiliated societies, comprising over 10,000 scientists, have joined the AIBS in its first year of existence. Ten thousand scientists have much to say and there should be organized channels through which they could speak. AIBS has already appointed a Committee on Publication Problems to study the question. Under the capable direction of A. J. Riker, University of Wisconsin, this committee is trying to come up with some publication answers for its colleagues.

TIME FOR GOVERNMENT ACTION?

It is not necessary to recount here the publication troubles besetting scientists in other fields. It is safe to say that for the most part the learned journals are refusing good articles, forcing authors to pay for the privilege of publication, or reducing articles to little more than abstracts. To the extent that the scientific press has been forced to exclude useful material the progress of science is being slowed. To that extent, the normal channels, as the situation now stands, are proving inadequate to the dissemination of the nation's scientific information.

The scientific journals are not to blame for the situation and they can do little to correct it. But the government agencies that provide the principal support of research might logically be expected to help shoulder the burden of publication that this research creates.

The scientific information divisions of the government agencies are concerned with the problem. They have listened to various schemes and suggested various schemes. Many sent representatives to the Royal Society Scientific Information Conference mentioned before, which brought together heads of departments in universities and technical colleges, directors of government laboratories, research associations and industrial laboratories, and editors of scientific publications in Britain and the United States. The conference was called "to discover in what directions improved services can be provided for the promotion of science by assisting working scientists in the dissemination and assimilation of scientific information" (*6*).

The first proposals the conference considered were for a panacea—one solution for all the world's scientific publication woes. The most publicized scheme was that presented by J. D. Bernal of Birkbeck College, London, for replacing the present system of independent journals with a system for distributing individually printed papers through a central agency. "National Distributing Authorities" would be created, to receive papers and refer them to panels of appropriate scientific societies. On acceptance, papers would be printed by the National Distributing Authorities concerned and distributed according to a detailed scheme.

Dr. Bernal's plan aroused such a storm of protest that he finally withdrew his paper from the conference agenda in the interest of harmony. The official protest of the Society for Freedom of Science (Great Britain) contains the following statement (*4*):

> Scientific publication is a natural and indispensable sequel to scientific investigation, the two together forming an indivisible process which rests essentially on the individual freedom of men of science to work, write and publish as they choose within the powers they recognize as their own. The scheme for centralized printing and issue of scientific papers seems to threaten these rights to scientific freedom very directly and to involve a great over-all loss of efficiency.

In view of this violent reaction it would seem wise to recognize the fact that we cannot hope to solve our problem with any one scheme. If the experience of the conference is any criterion, many solutions must be sought and many experiments undertaken before we can approach effectiveness. The conference made progress only when it settled down to tackling the problem by many methods in many places. Delegates returned to their countries determined to clean out their own closets first.

Proposed Steps for Government Research Agencies

These are the steps proposed, then, for action by government research agencies (but no one of the steps is adequate alone):

1. *Support of the normal channels.* It must be recognized that the normal channels through which scientific information is published, if they are to cope with a billion dollars of research annually, must be supported.

Existing legislation of course prohibits a government agency from supporting a private publication. That regulation need not be challenged. Support could be given to the learned societies or to groups of learned societies through their institutes to set up a central clearing office to cope with the publication problems of their own official journals. The American Institute of Biological Sciences has such a central unit under consideration to help solve the publication problems of its members, and funds are being sought for support from private research foundations. It seems only fair and right that the government agencies sponsoring research should lend their support, too.

How would this central publications unit function? It could consolidate weak journals into one effective stronger journal. It could negotiate with a printer a joint contract for a number of the journals of its constituent societies and thus obtain better printing rates by standardizing the physical characteristics of the journals. Type, paper stock, format, and other physical factors could be standardized and yet each journal could retain its individuality by means of such details as cover page and text divisions. The American Institute of Physics has already established itself as such a clearinghouse, with some success, but perhaps it could be more successful with outside support.

2. *Intra-agency publication.* Each government agency should provide some medium within its organization for publication of its own research. The National Bureau of Standards seems to have set a pattern that works effectively. Its unclassified *Journal of Research* is recognized by its scientists as worthy of carrying their papers. The *Journal* occupies a dignified, honored place, along with other well-recognized scientific journals. Furthermore, full reports on work reviewed in the *Journal* are readily available from the Government Printing Office and are widely used by scientists requiring detailed data on a specific research problem.

Other government agencies could establish such declassified journals, which would achieve reputation quickly by virtue of the unchallenged reputation of the scientists who would publish in them.

The last war demonstrated how scientists rally to the national defense. The success of the government's postwar research program attests that they are still interested in contributing to the national security. Offering them opportunity to publish in government journals would be a way to make them feel more effective. One ONR contractor, James A. Reyniers, of the University of Notre Dame, expresses a scientist's feelings in this respect: "One of the mistakes that governmental supported research can make is to become a vast silent repository into which a scientist's best efforts can be dumped with no echo in return."

3. *Exploration of other mediums.* We must constantly be alert to other supplementary mediums for disseminating scientific information. For instance, the government must support on an increasing scale symposia in which experts in a given field are brought together from government, industrial, and academic laboratories to tell each other what they are doing. The Royal Society Scientific Information Conference records as a recommendation of one of its working parties that "reports on 'symposia' are recognized as a valuable contribution to the recording of progress in science."

The Committee on Technical Information of the Research and Development Board plans to explore other existing mediums that can be used more and to better purpose.

The problem of adequate scientific publication is urgent. If, as Steelman recommends, the nation doubles its present research budget by 1957 then it must also double its effort in publication. It is a problem everyone concerned with science must face. Surely the original and active minds of science can solve this problem, as they have solved so many greater problems in the past.

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TECHNICAL PAPERS

Cysteine Protection against X Irradiation

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It is generally considered that many of the biological effects of radiation can be attributed to the activated water reactions which result from the irradiation. Inhibition or inactivation of enzymes and other materials by the actions of the decomposition products of water (OH, H_2O_2, O_2H, H) and the prevention or reversal of these effects under certain conditions have been reported by a number of investigators. Barron (*1*) has found that sulfhydryl-containing enzymes are readily oxidized by radiation and that it is possible to reactivate such enzymes after moderate radiation doses (100–200 r) on addition of a reducing agent such as glutathione. Reducing amino acids, glutathione, and ascorbic acid have been reported by Ephrati (*2*) to protect tetanus toxin against the effects of X-rays, whereas oxidizing substances are without effect. The finding by Evans (*3*) that the toxicity of irradiated water to *Arbacia* sperm is reduced by catalase also supports the concept of indirect action by the decomposition products of water. Although other related observations are cited in the literature (*4*), the extent to which oxidizing and reducing substances contribute to radiation damage *in vivo* has received little, if any, consideration. We should like at this time to communicate some of our observations concerning the influence of cysteine, the amino acid-containing –SH, and cystine, its oxidized counterpart, on the radiosensitivity of rats.

Since, in our experience, the product (toxicity, survival time, hematologic change) of radiation dose rate times duration of exposure appears to be a constant over a fairly wide range, we have employed brief exposures to fairly intense radiation on the assumption that a potentially protective material should be present in the blood and body fluids in high titer during the entire exposure. The radiation factors were: 250 kv, 15 ma, 0.5-mm Cu and 3.0-mm Bakelite filters, 27.5 cm target distance, and 210 r/min dose rate. Male and female rats (Sprague-Dawley) weighing 150–250 g received 800 r total-body X radiation in a single exposure. Animals of the same sex were irradiated in pairs, one serving as a control, the other as a treated animal.

Cysteine was injected into a tail vein either 1 hr before, 5 min before, or 5 min after exposure. Neutralized (pH 7) as well as unneutralized (pH 1) cysteine-HCl solutions were compared. Four different doses were employed (175, 350, 575, and 875 mg as cysteine per kg body weight). A 20% cysteine-HCl solution was used to decrease the volume of injected fluid. Since rapid injection of this concentrated solution, especially with the higher doses, may result in acute pulmonary edema and death (also true with 20% NaCl), the cysteine was injected slowly over a period of several minutes. Occasional sloughing of the tail was seen at the injection site. It is of interest that this reaction can be prevented by anesthetizing the rat before injection. Cystine is relatively insoluble at pH 7, and only an acid solution of this material was used (6.66%, pH 1, 280 mg/kg body weight). Irradiated controls for the neutralized cysteine-HCl groups were injected intravenously with an equivalent volume of a 5% solution of NaCl. All other controls received I.V. injections of 0.9% NaCl adjusted to the pH of the test solutions. All rats were fed Derwood Checkers and water ad lib.

TABLE 1

EFFECT OF PRETREATMENT WITH CYSTEINE AND CYSTINE ON SURVIVAL AFTER TOTAL-BODY X IRRADIATION WITH 800 ROENTGENS*

Treatment group	Dose mg/kg	pH of injected material	Number of rats	% Survival after irradiation				
				1st week	2nd week	3rd week	4th week	5th week
Control†		1	20	100	35	25	20	20
Cysteine	175		20	95	80	80	75	75
Control			22	86	82	27	27	27
Cysteine	350		19	100	95	89	89	89
Control			22	95	27	10	10	10
Cysteine	575		17	94	82	82	82	82
Control‡		7	14	57	7	7	7	7
Cysteine	350		15	100	87	47	47	47
Control			14	64	7	0	0	0
Cysteine	575		15	93	66	47	47	47
Control			27	70	19	7	7	7
Cysteine	875		25	92	92	84	80	80
Control†		1	27	52	22	15	15	15
Cystine	280		22	68	18	18	18	18

* All injections intravenously 5 min before irradiation.

† Controls received equivalent volume of 0.9% NaCl (pH 1) I.V.

‡ Controls received equivalent volume of 5% NaCl (pH 7) I.V.

Our findings reveal that pretreatment with cysteine markedly reduced toxicity from total-body X irradiation (82% survival, cysteine [pH 1] pretreated; 19% survival, irradiated controls). We have obtained similar results in mice (*5*). On the other hand, the disulfide, cystine, did not influence survival. Cysteine-HCl administered at pH 1 seemed equally effective at each dose level. However, with the neutralized preparation, greatest protection was afforded when the highest dose (875 mg) was used. This may possibly be explained by the fairly rapid oxidation of cysteine to cystine in a neutral medium before its administration. A similar reduction in mortality was observed when cysteine was given either 5 min or 1 hr before X irradiation. Significantly, injection of cysteine immediately after the exposure was ineffectual.

TABLE 2

INFLUENCE OF TIME OF INJECTION OF CYSTEINE ON SURVIVAL AFTER X IRRADIATION WITH 800 ROENTGENS*

Treatment group	Time of injection relative to X irradiation	Number of rats	% Survival after irradiation			
			1st week	2nd week	3rd week	4th week
Control	5 min before	15	73	20	13	13
Cysteine	5 min before	15	87	87	87	87
Control	1 hr before	15	80	20	20	20
Cysteine	1 hr before	15	100	87	80	80
Control	5 min after	16	88	19	13	6
Cysteine	5 min after	15	60	20	13	13

* Cysteine—875 mg/kg I.V., pH 7; controls received equivalent volume of 5% NaCl I.V.

These results are summarized in Tables 1 and 2. If all rats receiving cysteine at either pH 1 or 7 before their irradiation are considered as a single group, there are 92 survivors of 126 cysteine-treated animals (73%) as compared with 18 survivors of 134 irradiated controls (13%). These findings are highly significant statistically ($p < .001$).

Change in body weight was followed in a small group of rats pretreated with cysteine. Body weight is a fair prognostic sign of ultimate toxicity in the irradiated rat. Although the initial decrease was similar in the cysteine-pretreated and in the control animals, body weight recovered rapidly in the former.

We may conclude that cysteine, but not cystine, administered to rats prior to X irradiation in the nearly completely lethal range, greatly diminishes toxicity. This ameliorating influence may reside in the protection afforded certain critical cellular constituents against oxidation by the presence of cysteine or an intermediate of cysteine. A study of the protective influence of cysteine when administered at longer intervals before irradiation and by different routes as well as of other substances, such as glutathione, methionine, tryptophane, and ascorbic acid, is in progress. The metabolism of injected cysteine in the irradiated animal and its effect on the hematologic and histologic changes induced by radiation will be reported in detail in a subsequent communication.

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Humidifying Apparatus for Small Test Rooms

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The wood-element hygrostat illustrated in Fig. 1 was devised by Torgeson for use in an experimental lumber dry kiln at the U. S. Forest Products Laboratory, Madison, Wisconsin. Because of its simplicity and sturdiness it later was installed in each of two 600-cu-ft rooms used at the laboratory for accelerated testing of the resistance of wood and wood products to decay by pure cultures of wood-destroying fungi. As set, the hygrostat, in conjunction with the humidifier illustrated in Fig. 2, maintains a relative humidity of 70% with deviations of about ±2%. The temperature of the rooms is thermostatically kept at 80° F. Over several years, no adjustment in setting on account of changes in characteristics of the hygrostat has been needed. The reliable performance and simplicity of this humidification system should make it useful in many connections requiring humidity control within a moderately narrow range and at a level greater than that prevailing outside the space to be conditioned. It is already being used for biological work at a number of other laboratories.

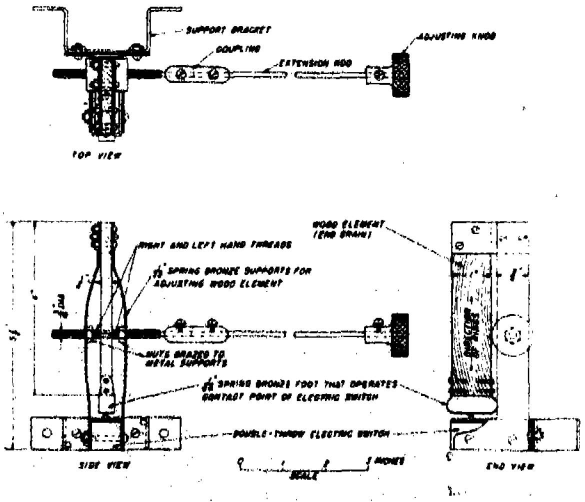
SUPPORT BRACKET
COUPLING
EXTENSION ROD
ADJUSTING KNOB
TOP VIEW
WOOD ELEMENT (END GRAIN)
RIGHT AND LEFT HAND THREADS
1/16" SPRING BRONZE SUPPORTS FOR ADJUSTING WOOD ELEMENT
NUTS BRAZED TO METAL SUPPORTS
1/16" SPRING BRONZE FOOT THAT OPERATES CONTACT POINT OF ELECTRIC SWITCH
DOUBLE-THROW ELECTRIC SWITCH
SIDE VIEW
0 1 2 3 INCHES
SCALE
END VIEW

FIG. 1. Hygrostat.

The novel features of the hygrostat consist of the wood element and a microtype switch that is sensitive to a very slight movement of the element. The wood should be free of defects and have as flat a grain as possible, for the flatter the grain the greater will be the dimensional change lengthwise of the element with a given change in relative humidity, and thus a correspondingly greater operating sensitivity of the hygrostat will be provided. The sapwood of hardwood species, such as maple and birch, makes a good element. The switch should be of the normally closed type. It is opened by pressure of the foot of the wood element against a protruding contact point, and this interrupts the flow of current through the heating coil of the humidifier. It is closed again and humidification is resumed as the element shrinks in response to decreasing relative humidity. No relay is required; the switch, which is designed for current loads up to 10 amps at 125 volts, is simply connected in series with the heating element of the humidifier.

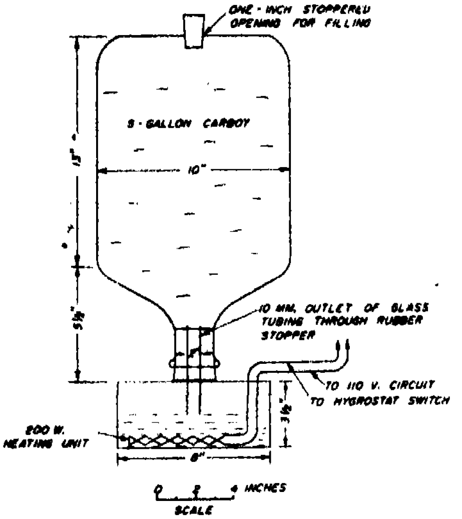

FIG. 2. Humidifier.

The relative humidity to be maintained is controlled by the proximity of the element foot to the switch contact point, which is regulated by adjusting the spacing between the spring bronze element supports. These supports are spread or contracted by turning the right- and left-hand threaded screw in the nuts brazed to the supports. The final adjustment is arrived at by trial and error, using a wet- and dry-bulb hygrometer to indicate when the proper setting has been made.

The humidifier (Fig. 2) consists of a closed 5-gal reservoir of water that feeds through 10-mm glass tubing into a glass evaporating pan. Heat is supplied by an open, 200-w heating coil submerged in the pan. A sealed heating unit probably would give longer service, although the open coil is remarkably durable when kept submerged. The smaller the heat output of the unit, the smaller will be the overrun in humidification resulting from lag in the response of the hygrostat.

The water reservoir is filled as necessary through a ½-in. hole bored in the top. A rubber stopper is inserted in the outlet tube during the filling process. Distilled water is used because of the extreme hardness of the tap water at Madison, although lime would not, of course, materially interfere with the operation of the apparatus if it were removed from the evaporating pan and heating unit frequently enough to prevent large accumulation.

Significant stratification of relative humidity and temperature in the controlled rooms at the laboratory is avoided by keeping an electric fan running at low speed in each room.

From measurements made in one of the rooms during the winter, it was found that about 873 g water/day was evaporated in maintaining the 70% relative humidity. The humidifier was in operation about 5.8 hr each day, which entailed a daily power consumption of about 1.16 kwhr. Corresponding summertime values were not measured, but are known to be considerably smaller. The room in this case is walled on three sides with double sheet rock panels with mineral wool insulation batting between them, and on the fourth side with unglazed tile. All conspicuous cracks and similar openings to the outside are sealed with calking compound, a measure that materially reduces the amount of humidification required.

To provide a relative humidity lower than that of the outside atmosphere, some arrangement for increasing the temperature (if this could be tolerated) or for dehumidification would, of course, be necessary. In any case, the wood-element hygrostat could be adapted to serve as the control apparatus.

Treatment of Nausea and Vomiting of Pregnancy with Dramamine—Preliminary Report

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Nausea occurs in approximately 50% of pregnancies, and in about 25% vomiting ensues. The severity of symptoms varies in individual patients. Frequently patients require hospitalization because of the excessive dehydration which occurs. However, in a study of 15,000 cases, Eastman and Hellman (*1*) have reported that in only one instance was interruption of the pregnancy necessary. The cause of these symptoms has never been definitely established.

Coincident with the study of the control of motion sickness with Dramamine (*2*), it was decided to investigate the effect of the drug on nausea and vomiting in pregnancy.[1] The following data are presented as a preliminary report of this investigation.

Forty-three women who had complained of these symptoms for 4–6 weeks had been given a number of remedies. Intravenous pyridoxine, oral pyridoxine, oral thiamine chloride, sedation, and psychotherapy had failed. Each patient was given 100 mg of Dramamine, three times daily. This dose was reduced to 50 mg three times daily for seven patients because of minor side-effects—drowsiness and vague subjective muscle tremors. Unknown to 10 patients, the drug was discontinued and a placebo of lactose, identical in appearance, was substituted.

Thirty-one patients (72.1%) of the 43 were completely relieved of their symptoms 3 hr after administration of Dramamine. Ten patients whose symptoms were controlled by the drug relapsed when a placebo was substituted, but immediately regained their normal health after Dramamine was again administered. Twelve patients (27.8%) of the 43 obtained no relief from the drug.

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[1] Dramamine supplied by G. D. Searle & Co., Chicago.

In summary, although the number of patients treated with Dramamine is small, the results are so encouraging that the Allergy Clinic and the Obstetrical Clinic of the Johns Hopkins Hospital and University are making an extensive comparative study. These data will be published in a subsequent report.

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Plasma and Liver Protein Levels in Rats Fed the Carcinogen 2-Acetylaminofluorene[1]

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Cook, Griffin, and Luck (*1*) have recently reported that azo dyes decrease plasma albumin and increase gamma globulin in rats. In addition, the carcinogenic activity of the drug can be correlated with the degree of change induced in these plasma components. The non-azo dye, 2-acetylaminofluorene (2AAF), however, failed to alter plasma protein levels after a 6-week feeding period, although its carcinogenic action is well known. Whether or not the drug would alter plasma protein levels when fed at different concentrations and for a longer time was considered of interest in elucidating this drug's actions.

The azo dyes induce liver tumors and have a definite effect on nucleic acid content of this organ (*2*, *3*, *6*, *7*). The non-azo dye 2AAF also causes formation of liver tumors and increases liver weight (*8*). We have extended these data to include estimations of liver water and protein in an effort to correlate the liver and plasma proteins, since the liver is a source of plasma albumin.

Forty-day-old female rats were maintained on Purina fox chow to which 0.03% or 0.15% of 2-acetylaminofluorene was added. The diets were fed ad lib. for 100 days, after which time the rats were bled by cardiac puncture under light ether anesthesia and the plasma was analyzed for nonprotein nitrogen, total plasma protein, and albumin and globulin concentrations by salt fractionation methods previously reported (*5*). The liver was dried to constant weight, ground to uniform consistency, and analyzed for total nitrogen. The nitrogen values were converted to protein by use of the factor 6.25.

Body weight increase was recorded at weekly intervals and the control rats increased from 100 to 237 g in 100 days. Body weight increase of rats fed 0.03% of 2AAF followed the controls for 11 weeks, starting at 102 g and increasing to 202 g, and then leveled off. The incorporation of 0.15% 2AAF in the diet resulted in an average body weight change from 90 to 164 g. These rats' weight at 6 weeks was constant for a 2-week period, then it increased slowly for 4 weeks but leveled off again. The results simulate those reported by Wilson *et al.* (*9*).

TABLE 1

PLASMA PROTEIN CONCENTRATIONS OF FEMALE RATS FED 2-ACETYLAMINOFLUORENE FOR 100 DAYS

Diet	No. of rats	Hematocrit %	NPN in mg%	Plasma proteins in g%*		
				total	albumin	globulin
Fox chow	6	40.4 ± 1.2	50 ± 3.0	4.99 ± 0.11	2.42 ± 0.06	2.57 ± 0.11
Fox chow + 0.03% drug	6	42.4 ± 1.2	51 ± 2.4	5.06 ± 0.14	2.52 ± 0.07	2.54 ± 0.18
Fox chow + 0.15% drug	5	40.4 ± 1.1	47 ± 2.0	4.64 ± 0.09	1.99 ± 0.13	2.65 ± 0.13

$* \; \sigma = \sqrt{\frac{\Sigma d^2}{N(N-1)}}$

TABLE 2

LIVER PROTEIN OF FEMALE RATS FED 2-ACETYLAMINOFLUORENE FOR 100 DAYS

Diet	No. of rats	Wt in g	H_2O %	Liver protein*		
				Dry wt %	Total g	Total g/100g BW
Fox chow	6	7.77 ± 0.4	70.1 ± 1.2	65.4 ± 0.8	1.43 ± 0.2	0.620 ± 0.015 (0.580 – 0.696)
Fox chow + 0.03% drug	7	8.08 ± 0.3	70.8 ± 0.8	60.8 ± 1.0	1.44 ± 0.04	0.710 ± 0.015 (0.665 – 0.791)
Fox chow + 0.15% drug	7	7.89 ± 0.4	70.3 ± 0.2	61.1 ± 1.9	1.36 ± 0.05	0.852 ± 0.024 (0.755 – 0.939)

$* \; \sigma = \sqrt{\frac{\Sigma d^2}{N(N-1)}}$

Table 1 shows the hematocrit, plasma nonprotein nitrogen, and plasma protein concentrations. Plasma albumin concentration was significantly subnormal in rats fed 0.015% of 2AAF, but other analyses were unchanged.

To determine whether liver size or protein content was

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[1] Supported in part under a grant-in-aid from the American Cancer Society upon recommendation of the Committee on Growth of the National Research Council.

altered in rats exhibiting subnormal plasma albumin levels, these organs were analyzed for total protein, and the data are presented in Table 2. It is apparent that liver size and water content were unchanged by the drug, and despite a slight decrease in percentage of protein the total protein content of the liver was normal. Since the animals fed the drug lagged in growth rate the liver protein in relation to body weight was significantly increased and in proportion to the amount of drug fed. This is interesting, in that the slower growth rate with reduced food intake would seem more likely to be associated with a smaller liver. Reduction of food intake will rapidly decrease liver size and protein level (*4*). 2-Acetylaminofluorene can therefore significantly increase liver protein to body weight ratios without altering plasma protein concentrations, but a decrease in plasma albumin can be induced if drug concentration is high.

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Correlation of Browning, Fluorescence, and Amino Nitrogen Change with Destruction of Methionine by Autoclaving with Glucose[1]

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The destruction of lysine by autoclaving in the presence of glucose was demonstrated by Stevens and McGinnis (*8*). These workers observed that the autoclaved mixture of glucose and lysine was dark brown in color. Patton and Hill (*6*) reported that tryptophane, in a bacteriological culture medium containing glucose, was destroyed to a certain extent by autoclaving. This destruction was not observed when sucrose was substituted as a source of carbohydrate. Hsu, McGinnis, and Graham (*4*) found that methionine was destroyed or rendered unavailable to chicks by autoclaving in the presence of either glucose or lactose, and to a certain extent in the presence of sucrose. In contrast, methionine was unaffected by heating in the presence of starch or dextrin. Acid hydrolysis of the autoclaved mixture of glucose and methionine failed to liberate the amino acid for support of chick growth. They also found that autoclaving a soybean protein with glucose damaged the protein to the extent that supplementary methionine, lysine, and tryptophane failed to restore its nutritive value for chicks. These observations indicate that other amino acids, in addition to the three named, were destroyed or rendered unavailable. Evans and McGinnis (*2*) showed that cystine in soybean oil meal was destroyed during autoclaving. In contrast, the same autoclaving treatment failed to alter the methionine content. Patton, Hill, and Foreman (*7*) reported that lysine, arginine, tryptophane, and histidine were destroyed when an intact soybean protein was refluxed in a 5% glucose solution for 24 hr. In view of the results reported by Hsu, Graham, and McGinnis (*5*) showing that the concentration of amino acids or crude protein in an aqueous solution of glucose markedly influenced the amount of browning and destruction of amino acids, it should be pointed out that the concentration of protein used by Patton, Hill, and Foreman (*7*) was only 1%.

TABLE 1

Correlation of Browning, Fluorescence, and Amino Nitrogen Change with Destruction of Methionine by Autoclaving with Glucose

Methionine mg/culture	Dry wt of mold in mg			Brown color	Fluorescence equivalents	α-Amino nitrogen
				optical density at 380 mμ (× 100)	mg quinine sulfate/g methionine	% of theoretical value
0.1*	11.1	11.1	11.1§	0	0	102.2
0.2	18.5	18.5	18.5			
0.4	32.0	34.4	33.2			
0.6	55.2	53.2	54.2			
0.8	64.9	61.9	63.4			
1.0	69.7	68.9	69.3			
0.1†	11.4	11.2	11.3	5.6	.965	93.7
0.2	18.3	18.3	18.3			
0.4	31.8	34.9	33.4			
0.6	50.2	52.4	51.3			
0.8	58.9	62.9	60.9			
1.0	67.0	63.1	65.1			
0.1‡	..	3.5	3.5	180	14.25	15.1
0.2	3.8	3.8	3.8			
0.4	5.8	5.8	5.8			
0.6	6.7	6.2	6.5			
0.8	8.2	8.2	8.2			
1.0	9.5	9.6	9.6			

* Methionine autoclaved alone for 2 hr at 120° C.

† Methionine (2 g) dissolved in 100 ml of 8% glucose solution and autoclaved 2 hr at 120° C.

‡ Methionine (2 g) mixed with glucose (8 g) and autoclaved 2 hr at 120° C.

§ Average of duplicates.

Chen, Medler, and Harte (*1*) found that highly fluorescent substances were formed from certain amino acids when they were heated with Denigès reagent (paraformaldehyde and sulfuric acid). A similar observation had previously been made in this laboratory when glucose was used to furnish the aldehyde group instead of Denigès reagent. All of the amino acids tested (approximately 15) formed fluorescing substances when mixed with glucose and autoclaved at 125° C for 1 hr.

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[1] Published as Scientific Paper No. 829, Washington Agricultural Experiment Station, Institute of Agricultural Sciences, State College of Washington, Pullman.

[2] Now at Department of National Health and Pensions, Ottawa, Ontario, Canada.

The experiments described in this paper were conducted to determine whether a relationship exists between the degree of browning, the production of fluorescing substances, changes in amino nitrogen, and the ability of methionine autoclaved in the presence and absence of glucose to support growth of a methionineless mutant of *Neurospora crassa* No. 38706.

The methionine used in these experiments was treated as indicated in footnotes to Table 1. These differently treated samples of methionine were appropriately diluted for the determination of optical density or brown color concentration, fluorescence, amino nitrogen, and methionine content as evidenced by the ability of the material to support growth of *Neurospora crassa* No. 38706.[a] The results obtained are summarized in Table 1. From these data, it is evident that brown color formation, fluorescence, and decreased amino nitrogen are associated with destruction of methionine brought about by autoclaving in the presence of glucose, but in the absence of an excessive amount of water. Under the experimental conditions in this laboratory, autoclaving methionine in an 8% solution of glucose failed to bring about any marked destruction or changes in brown color, fluorescence, and amino nitrogen.

The data clearly show the important influence of water on the destruction of methionine autoclaved in the presence of glucose, on the loss of amino nitrogen, and on the formation of brown color and fluorescing substances.

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[a] Samples were diluted in 0.1 M phosphate solution pH 4.8. Fluorescence was determined in the Coleman Photofluorometer, using the B_1 filter. The instrument was standardized at 100 with quinine sulfate solution (0.1 mg/l 0.1 N H_2SO_4). Brown color was measured as optical density of the phosphate solution at 380 mμ in the Coleman Universal Spectrophotometer. Amino nitrogen was determined by the method of Van Slyke (9). The methionine assay was conducted as outlined by Horowitz (3).

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Comments and Communications

Characteristics of Some Disease-free Ornamental Plants

Modern medicine has learned that people in good health are worth study. It may be hoped, then, that plant pathologists will learn to give special consideration to those plants which have few diseases or pests. As a step in this direction, information has been assembled in this paper regarding a considerable group of ornamental plants in which, in the eastern United States at least, no important diseases or pests are known.

Dodge and Rickett include in *Diseases and pests of ornamental plants* (1943) the names of approximately 75 plants which are practically disease-free. This is almost unique in such a book. In the introduction, the scope and purpose of the authors are carefully defined. "We have tried to select those [diseases and pests] which have been most injurious in the eastern United States; most of these are also the most troublesome in other parts of the country and of the world. . . . Our selection of cultivated plants is based upon the 3,000 species and varieties grown at the New York Botanical Garden." The book thus serves admirably as a check list of diseases and insect pests of ornamental plants in the northeastern United States; over 500 genera are included.

In studying 75 disease-free plants, answers to three questions were sought. What are their characteristics? What, if any, characteristics do they have in common? Is it possible that these common characteristics have any bearing on their disease-free status in the eastern United States? (Much of the work of compiling the information on which this paper is based was done by members of a class in the epidemiology of plant diseases.)

The plants are not taxonomically related. They are scattered through 38 families; the largest number in any one family being nine in the Compositae. They show diverse growth habits. There is one tree (Ginkgo), one woody vine (Wisteria), eight shrubs, and the rest are herbs. The plants which have no important diseases or insect pests are predominantly seed-propagated and are either annuals or very short-lived. Only one is reproduced by bulbs, 17 are reproduced chiefly by division; the rest either may be, or must be, grown from seed.

They are also predominantly of foreign origin. Only 15 (20%) seem to be natives of the continental United States. Eurasia has furnished 33; others come from Africa, Australia, South America, and various tropical localities. An introduced plant (all but 15 of these 75 plants were introduced into the United States) which has been brought in as seed may well have left its native parasites behind, to its own great advantage. (Bailey, L. H. *Trans. Ind. Hort. Soc.*, 1892, p. 62. See also *The survival of the unlike*, 2nd Ed. New York: Macmillan, 1897, p. 180. Stevens, N. E. *J. Amer. Soc. Agron.* and several papers cited therein, 1948, 40, 841). Many of these plants have no near relatives in the region. Actually more than half (43) of the genera are not mentioned in standard floras of the northeastern United States as either native or, established. Finally, all are of minor commercial importance. Many are actually rare: their names are listed in catalogs of dealers in rare seeds. None of them is found growing in large acreages. Indeed, among them are many plants used in rock gardens and borders.

A study of these facts leads to the conclusion that many of these plants may well be escaping disease and insect pests because of the way in which they are now grown, rather than because they are actually immune or even resistant. The very fact that these plants are of minor commercial importance and are usually grown in very small groups is a great safeguard. A mutant strain of a fungus, for example, which was seriously pathogenic on a plant or clump of Anoda, an annual so rare as not to be mentioned in Bailey's *Cyclopedia of horticulture*, might well kill its available hosts, produce spores, and itself die out without any viable spores ever reaching another plant of Anoda. Nowhere would a new mutant fungus find large areas of any of these plants on which it might produce the abundant inoculum so essential to the initiation of a great epidemic. Many of these plants are further isolated because they are predominantly grown in cities.

The circumstance that many of these plants have no near relatives among wild plants of the region affords further protection. It is undoubtedly true that some pathogens, particularly some viruses, and such fungi as *Botrytis cinerea* have a wide range among unrelated green plants. It is also true that serious diseases or insect pests of cultivated plants are more likely to come from closely related plants. Slightly more than 100 genera were reported as having no fungi of importance, and the average number of insects was less than one (0.4). On more than 100 genera only one fungus of importance was reported, and there was an average of less than one insect per genus (0.7). Almost 100 genera had two important fungus pathogens, and the average number of insects was almost exactly one. In two groups of 54 genera, 3 and 4 fungi respectively were reported, while the average numbers of insects for these categories were 1 and 2. On only 23 genera were there 5 important fungus pathogens reported and these had an average of 3 insect pests. The 15 genera which had 6 fungi had an average of 3.5 insect pests. On the small groups having 7, 8, and 9 fungi, the average numbers of insects found were 6.0, 7.2, and 6.8 respectively. For the few genera of ornamental plants which had from 10 to 20 fungi, the number of insects ranged from 6 to 18. This gives a correlation of 0.8–0.06. It seems probable that the same qualities in a host which favor parasitism by various fungi also favor parasitism by various insects.

Since the number of insects jumped rather sharply in the group of hosts with 7 important fungi, those plants which had 7 or more fungus pathogens with an average of 6 or more insect pests were classed together as a group in which pathogens might well be considered important. Exactly 40 genera were found to belong in this class.

In one respect only do the ornamental plants on which occur numerous pathogens resemble the disease-free group with which they are here being compared. These plants also are widely scattered taxonomically. Twenty-eight plant families are represented; the largest number of genera in a single family being four each in the Ranunculaceae and Compositae.

In this group also there is a diversity of growth habits, but with a decided difference in distribution. Nine genera, almost one-fourth, are trees as against one in the disease-free group. Shade trees are in general exposed to attacks of fungi and insects more than most ornamental plants, since they remain for many years in one place. Many are very large and receive only a minimum of protective treatments. Woody vines are represented by one genus or two closely related genera. Five genera are wholly or chiefly shrubs and the rest are herbs.

Vegetative reproduction is relatively much more common in this group. Of the 31 herbaceous genera, 7 are propagated by bulbs, and 8 more by rooted cuttings, division, or other vegetative means, the rest by seeds.

Again in contrast to the disease-free group, of which only 15 (20%) appear to be native to the continental United States, 24 or well over half of the genera with many diseases and pests, are native, and 5 more are well established in the area we are considering. The imported plants come from Eurasia, the Orient, the Mediterranean region, the tropics, and South Africa.

The greatest contrast between these two groups, however, is in the abundance—that is, number of individual plants—in most of the genera represented in this disease-susceptible group. Such trees as elm and oak, for example, are among our commonest shade and forest trees. Greater abundance resulting from intensive cultivation is clearly indicated by the commercial importance of many of the shrubby and herbaceous genera.

Stated in another way the material summarized in this communication emphasizes the disease hazards resulting from growing perennial plants as compared to annuals, and from growing large concentrated masses of the same kind of plant—especially if vegetatively propagated. These hazards are of course characteristic of much of present day fruit culture and floriculture. In raising rare, imported plants, these hazards are avoided, especially when plants are grown from seed.

NEIL E. STEVENS

University of Illinois, Urbana

Association Affairs

Headquarters hotels for the 116th Meeting of the AAAS in New York City, December 26–31 are as follows:

Statler: AAAS, Annual Science Exposition, Science Theatre, Visible Directory; Sections B, C, F, M, Nm, Nd, Np; zoological societies, *viz.*, American Society of Parasitologists, American Society of Zoologists, Society of Systematic Zoology, American Society of Protozoologists; American Microscopical Society, American Society of Naturalists; American Institute of Electrical Engineers, Instrument Society of America, Technical Society Council of New York, Metropolitan Section of Mechanical Engineers; American Dietetic Association; Beta Beta Beta, Phi Lambda Upsilon, Sigma Delta Epsilon, and Sigma Xi.

New Yorker: Sections E, H, I, L, Q; Geological Society of America, American Geographical Society of New York, Association of American Geographers; AAAS Cooperative Committee; the Science teaching societies, *viz.*, American Nature Study Society, National Association of Biology Teachers, National Science Teachers Association; Society for Research in Child Development; American Sociological Society, Rural Sociological Society; Philosophy of Science Association, American Philosophical Association.

McAlpin: Sections G, O; the plant science societies, *viz.*, American Society of Plant Physiologists, American Society of Plant Taxonomists, Botanical Society of America, Mycological Society of America, Torrey Botanical Club, American Fern Society, American Bryological Society, Phycological Society of America.

Martinique: American Phytopathological Society.

Governor Clinton: Sections A, D, K; American Mathematical Society, Institute of Mathematical Statistics, Mathematical Association of America; American Society of Limnology and Oceanography, Biometric Society, Ecological Society of America, Genetics Society of America, American Society of Human Genetics, Society for the Study of Evolution; Academy of World Economics; Alpha Epsilon Delta; Phi Kappa Phi; Pi Gamma Mu; Metric Association.

Coupons for advance registration and hotel reservations will be found on pages viii and ix, respectively, of this issue.

Five AAAS-sponsored symposia are being planned. While others may be announced at a later date, those definitely scheduled are:

Science in General Education (at all levels). Earl McGrath, Commissioner of Education of the U. S. Office of Education, Morris Meister, principal of the High School of Science, New York City, and Paul B. Sears, chairman of the Department of Botany, Oberlin College, will discuss problems of science in general education, the importance of biological sciences, and the understanding of science for all populations. General secretary Karl Lark-Horovitz is in charge.

The Improvement of Science Teaching **on the College Level.** James B. Conant, president of Harvard University, Alan Gregg, director of medical sciences of Rockefeller Foundation, W. F. Loehwing, head of the Department of Botany, State University of Iowa, and Fernandus Payne, dean of the Graduate School, Indiana University, will each present a different aspect. President Elvin C. Stakman is in charge.

Both symposia will be held on Thursday afternoon, December 29, in the Statler's Grand Ballroom.

The Present State of Physics (Section B). Four sessions will cover elementary particles, chemical physics, physics of the solid state, and biophysics. The symposium is being arranged by F. S. Brackett, chief, Low Energy Radiation Biology Section, Experimental Biology and Medicine Institute, National Institutes of Health, Bethesda, Maryland. All sessions will be held in the Georgian Room of the Hotel Statler. Session 1—Thursday afternoon, December 29; Session 2—Friday morning; Sessions 3 and 4, consecutively—Friday afternoon, December 30. A symposium volume is contemplated.

Steroid Hormones and Sex Differentiation in Vertebrates (Section F and American Society of Zoologists). Several speakers will discuss this subject in the principal vertebrate classes. The symposium is being arranged by Section F Secretary J. H. Bodine of State University of Iowa, and L. V. Domm, Department of Anatomy, University of Chicago. The session will be held in the Grand Ballroom of the Hotel Statler on Friday afternoon, December 30.

Botany in the Service of Mankind (Section G). Four members of this panel have already accepted. Frans Verdoorn, of *Chronica Botanica*, will discuss "International Organizations and Activities," Knowles A. Ryerson, dean of the College of Agriculture of the University of California, "Botany and Point Four [of President Truman's Inaugural address]," and S. T. Dana, dean of the School of Forestry and Conservation of the University of Michigan, "Botany in the Service of National and World Forestry"; Gove Hambidge, special assistant to the director, Food and Agriculture Organization of the United Nations, "Botany in the Service of National and World Agriculture," and a fifth speaker will take "Botany in the Service of National and World Health." W. C. Steere, chairman of Section G, and chairman, Department of Botany, University of Michigan, will act as moderator. Section Secretary, Stanley A. Cain, Cranbrook Institute of Science, is arranging the program. The session will be held Thursday afternoon, December 29 in the Winter Garden of the Hotel Statler.

An atomic energy demonstration and lecture by J. R. Dunning of Columbia University, sponsored by Sigma Xi, is scheduled for Monday evening, December 26, in the Grand Ballroom of the Hotel Statler. The Annual Address of this society will be given Tuesday evening, December 27.

NEWS and Notes

A Presidential Commission on Science and National Security was recently proposed by the Federation of American Scientists in a letter cosigned by 145 prominent scientists and sent to the President July 8. Initial reaction from the White House indicates that even wider sponsorship will be required if the proposal is to be given favorable consideration. The text of the letter is reproduced here:

"The current controversy over the Atomic Energy Commission has once again focused attention on the problem of security in relation to scientific discovery. We are deeply disturbed by the misconceptions which have been voiced recently on this subject, and by some measures which have been proposed for the prevention of espionage directed at our atomic weapons. We fear that in the heat of controversy important values are being overlooked and may be carelessly sacrificed.

"The dilemma of secrecy vs. long-range security has plagued us since the end of the war. The demonstration of the potency of science as a military adjunct, so dramatically and horrifyingly driven home at Hiroshima, has led to two almost universally accepted conclusions—first, intensive cultivation of science is essential to national security; second, since scientific knowledge, of certain kinds and in certain circumstances, may have great military significance there are advantages in withholding it from potential enemies. We are slowly becoming aware, as a nation, that ill-considered implementation of these two conclusions can lead to very serious conflicts. For the narrowest interpretation of military security demands that we reveal nothing that might conceivably be useful to a potential enemy, and that the information of possible military significance available to any individual scientist be kept at a minimum. On the other hand, the experience of science is that the withholding of knowledge, or the abridgment of freedom of thought, is a deadly contamination which very rapidly inhibits research. How are we to reconcile these two apparently conflicting requirements? How can we safeguard in *existing* knowledge what is essential to military security, without so debilitating science as to sacrifice the hope of obtaining *additional* knowledge?

"You yourself, Mr. President, pointed out the importance of scientific progress to the national welfare, and the grave danger to science of the continuance of an atmosphere of suspicion and distrust. For five years we have been trying to balance the legitimate security needs of the nation against the equally insistent needs of free scientific inquiry. Largely this has been done by improvisation in individual instances with little attempt to develop or follow a comprehensive national policy. Security decisions have been left to individual government agencies, often subject to various uninformed pressures. Without benefit of full discussion of the issues, public understanding has remained at a low level and, in consequence, public opinion has drifted perilously close to hysterical insistence upon secrecy at whatever cost. The situation has become so threatening, not only to scientific progress but to traditional American political freedom, that we feel that only through action on your part can the problem be brought under control.

"Therefore, we respectfully urge that you appoint, at your earliest convenience, a Special Commission on Science and National Security. We urge that this Commission be composed of foremost scientists and educators, outstanding men of public affairs, and representatives of Congress, the National Military Establishment, and other agencies of the Executive Branch. We urge that this Commission make a full investigation of the entire problem of security requirements in relation to the requirements for maximum development of science. We believe that the Commission should study, among others, the following questions:

1. What are the limits where excessive attempts at secrecy diminish instead of preserve our national security?
2. What are the areas of science to which security measures can and should be applied?
3. What classification procedures give maximum protection of information of military value with minimum restriction of exchange of information of purely scientific value?
4. To what extent, and under what conditions, should classified research be conducted outside of military laboratories?
5. What types of clearance procedures are effective, and admissible within the bounds of scientific and democratic tradition, in military laboratories, in non-military governmental laboratories, in nongovernmental laboratories?
6. What would be the effect on the morale of scientists and on our total scientific program of applying political tests for participation in non-secret scientific work through requirement of (1) oaths and affidavits, or (2) investigation and clearance?
7. What have been the effects of present security measures and procedures on our scientific research programs, particularly in government?

"We believe that the Commission should study these matters, not only with the objective of reporting to you its conclusions and recommendations, but with the thought as well of providing a factual background on security procedures now in use, specific studies of the effects and effectiveness of these procedures, ways in which similar problems are handled in other countries, etc. We have been too long security-conscious with insufficient security education.

"American scientists differ in no way from their fellow-citizens in their desire to protect the best interests of their country. They seek no special dispensations or privileges. In opposing extreme advocates of military security they are really seeking not less security, but more. Our real strength lies not in the guarded knowledge of the moment, but in our ability to keep in the forefront of advancing knowledge. We recognize that the issue of security vs. freedom of science is one of public policy and that opinions other than those of scientists must enter into its resolution. It is for this reason, and because we are convinced that the matter is of urgent importance, that we ask for the establishment now of a Special Presidential Commission of broad representation and scope.''

About People

Hans Staub, professor of physics at Stanford University, has been appointed professor of physics and director of the Institute of Physics at the University of Zurich. Dr. Staub, a native of Switzerland, has been at Stanford since 1938.

Robert C. Parkin, member of the staff of the Council on Medical Education of the American Medical Association, has been appointed assistant professor of clinical medicine and coordinator of postgraduate medical education at the University of Wisconsin Medical School.

W. D. Graham, assistant biochemist in the Division of Poultry Husbandry, Washington State College Agricultural Experiment Station, has joined the staff of the Department of National Health and Pensions, Ottawa, where he will conduct research in antibiotics.

Leslie J. Todd, of the Department of Chemistry at the University of Indiana, has been appointed associate professor of chemistry at Kent State University, Kent, Ohio.

Robert H. W. Strang, consulting oral surgeon and lecturer in orthodontia at Columbia and Temple Universities, has been appointed director of the newly founded Fones School of Dental Hygiene at the University of Bridgeport in Connecticut. The Connecticut State Dental Association recently gave Dr. Strang its Alfred C. Fones medal for his service to the dental profession.

Archie D. Hess, for several years chief biologist of the Health and Safety Department of the Tennessee Valley Authority, and former director of Malaria Control Research, has accepted a commission as scientist in the Reserve Corps of the Public Health Service and has been assigned to the Technical Development Division of the Communicable Disease Center at Savannah, Georgia, as an assistant chief of the division.

A. P. Elkin, professor of anthropology at the University of Sydney, will conduct a review of accomplishments in social anthropology in Papau and Melanesia for the South Pacific Commission. Dr. Elkin will make recommendations on what still needs to be done and assess priorities for further work in the field.

Joseph P. LaRocca, pharmacist at the Naval Research Laboratory, Washington, has been appointed professor of pharmacy at the University of Georgia.

Visitors to U. S.

E. Navajas, entomologist of the Instituto Biologico, São Paulo, Brazil, recently visited entomologists and others in the Smithsonian Institution and the Department of Agriculture.

Walter A. Saborido, president of the Argentine Medical Association and professor of gynecology at the University of Buenos Aires Medical School, recently visited the University of Texas Medical Branch, Galveston, to confer with Willard Cooke, professor of obstetrics and gynecology, and W. W. Nowinski, associate professor of neurochemistry.

Hilda Levi, of the Bohr Institute and the Zoophysiological Laboratory of the University of Copenhagen, is spending six weeks studying autoradiography at the Department of Radiation Biology, University of Rochester School of Medicine and Dentistry. Dr. Levi's study is supported by the Danish Rask-Ørsted Foundation and the Rockefeller Foundation. She plans to teach autoradiography in a course on isotope tracers this year at the University of Copenhagen.

Recent visitors who conferred with scientists at the National Bureau of Standards included: **Domingo Albano** of the Argentine Airlines; **Palle Birkelund,** assistant librarian, University Library, Copenhagen, Denmark; **J. Cornelius,** production superintendent, and **A. R. Sloman,** research manager, Associated Pulp and Paper Mills, Ltd., Burnie, Tasmania; **C. C. Gotlieb,** of the Computation Centre, McLennan Laboratory, University of Toronto, Canada; **J. N. Mitchell,** professor at the University of Bristol, England; **J. R. H. van Nouhuys,** director of the Fibre Research Institute, T.N.Q., Delft, Holland; **J. V. Rao,** engineer at the Public Works Department, Madras, India; **N. S. R. Sastry,** member of the Reserve Bank of India, Bombay; and **John Shone,** member of the London Blood Supply Depot, New Barrett, Herts, England.

Grants and Awards

The University of Illinois College of Medicine has received $15,000 from the U. S. Public Health Service for a study of the effects of the betatron X-ray beam on bone and cartilage. Research will be directed by Roger A. Harvey, of the Department of Radiology, and G. A. Bennett, of the Department of Pathology.

Philip S. Hench and E. C. Kendall, of the Mayo Clinic, Rochester, Minnesota, will receive jointly a **Lasker Award for Administrative and Scientific Achievement** in recognition of their recent studies in arthritis. The $1,000 award will be presented at the 77th Annual Meeting of the American Public Health Association in New York City on October 25.

The Paul-Lewis Laboratories Award in Enzyme Chemistry will be presented to Henry A. Lardy, associate professor of biochemistry at the University of Wisconsin, at the American Chemical Society's Atlantic City meeting in September. Dr. Lardy is receiving the $1,000 award for his recent research on biotin. The society will also honor Agnes Fay Morgan, chairman of the Department of Home Economics at the University of California, who will receive the **Francis P. Garvan Medal** for her studies in nutrition and dietetics.

Meetings and Elections

A Committee on Calorie Requirements, called by the Nutrition Division of the Food and Agriculture Organization of the United Nations (director: W. R. Akroyd), will meet in Washington, D. C., September 12. The committee will consider proposals of the secretariat and members aimed at defining scales of calorie allowances applicable to widely different types of population and conditions. Members of the committee are E. J. Bigwood, professor of biochemistry and nutrition, University of Brussels, Belgium; Ancel Keys, director, Laboratory of Physiological Hygiene, University of Minnesota; R. E. Johnson, until recently director, U. S. Army Medical Nutrition Laboratory, now professor of physiology, University of Illinois; Isabella Leitch, director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire, Scotland; Josué de Castro, director, Nutrition Institute, Rio de Janeiro, Brazil; Emile F. Terroine, director of the National Center of Study and Research on Alimentation and Nutrition, Paris, France; Hsien Wu, professor of biochemistry, Berkeley, California; and A. G. van Veen, professor of biochemistry, Biochemical Laboratory, Technische Hoogeschool, Delft, Holland. F. W. Clements, former director, Institute of Anatomy, Canberra, Australia, now head of the WHO Nutrition Section, will also attend the meeting. Jean Mayer of the FAO Nutrition Division will act as technical secretary.

A symposium on brucellosis will be held September 22–23 at the National Institutes of Health, Bethesda, Maryland. The veterinary, public health, clinical, bacteriological, and control aspects of the disease will be discussed. All sessions will meet in Wilson Hall, Administration Building. The symposium is being sponsored by the Bureau of Animal Industry, the National Research Council, and the National Institutes of Health (see *Science*, July 8, p. 36). Inquiries should be addressed to Dr. James T. Culbertson, Executive Secretary, Microbiology and Immuniology Study Section, National Institutes of Health.

The 1949 Conference on Instruments and Measurements and the **International Instruments and Measurements Exhibition,** sponsored by the Royal Swedish Academy on Engineering Sciences and the Association of Technical Physicists of Sweden, will take place in Stockholm September 21–24 and September 22–October 2, respectively. The conference has been arranged in four principal sessions: physical methods in chemical analysis and structure analysis; industrial control (methods); miscellaneous methods of measurements; and apparatus and instruments. Papers are invited and abstracts should be submitted before *September 1* to Y. Axner, Secretary, Kungl. Tekniska Högskolan, Stockholm 26, Sweden. Completed papers must be received by *September 24.* Hotel reservations should be made as soon as possible by letter to Hotellbyran, S:t Eriks-Mässan, Stockholm 5.

AEC News

A three-man temporary advisory committee has been set up to recommend ways to establish continuing cooperation between the electric power industry and the AEC. The committee plans to conduct a firsthand study of the commission's reactor program with a view to identifying potential areas of mutual interest to the power industry and the commission and make recommendations for bringing about a continuing program of cooperation in these areas. Committee members are Philip Sporn, president of the American Gas and Electric Company, chairman; Edward W. Morehouse, vice president of the General Public Utilities Corporation in New York; and Walton Seymour, director of the Division of Power in the Secretary's Office, Department of the Interior. It is expected that the survey will be completed and recommendations submitted by March 31, 1950.

On August 2, the third anniversary of the distribution program of radioactive isotopes for use as tracer atoms by U. S. researchers, the **Isotopes Division** announced that a total of 7,613 shipments had been made, for use in science, agriculture, medicine, and industry. Of this total, 7,025 have gone to research laboratories and hospitals in the U. S. Since September 1947, when foreign distribution was announced, 588 shipments, mainly for use in medical and biological studies, have gone to researchers in Argentina, Australia, Belgium, Brazil, Canada, Colombia, Denmark, Finland, France, Iceland, Italy, Netherlands, New Zealand, Norway, Peru, Spain, Sweden, Switzerland, Turkey, Union of South Africa, and the United Kingdom. Countries which are qualified to receive shipments but have not yet instituted orders are Chile, Cuba, Guatemala, India, Ireland, Lebanon, Mexico, and Uruguay.

In response to recommendations of its **Industrial Advisory Group,** the AEC is testing the possibility of selecting, screening, and declassifying information useful to industry without revealing its specific relevance to the atomic energy program. An advisory committee, representing professional societies and the business press, has been appointed and it in turn will recommend members for a small group of workers in the field of metallurgy who, after being cleared, will examine metallurgical information which may be declassifiable. This group will make recommendations of information that might be particularly useful to American industry and any of this information the AEC may declassify will be made available for publication to established metallurgical journals. If the metallurgy program proves effective the procedure may be extended to other fields of technology.

Oak Ridge National Laboratory has developed a relatively inexpensive radioantimony-beryllium neutron source which is now available for U. S. distribution as allocated through the AEC Isotopes Division.

The sources use a core of 32 grams of antimony metal surrounded by a $\frac{3}{16}$-in.-thick beryllium metal cup, the assembly being enclosed in an aluminum jacket. The entire unit is placed in the pile and the antimony activated to the desired level. It has been found that the saturated source will emit a total of about 8 million neutrons per second. A customer will have to make arrangements beforehand to provide a suitable storage space for the source; a lead pig with walls 4 in. thick would probably be sufficient.

Deaths

Neil E. Stevens, 62, professor of botany of the University of Illinois, died June 26 at his home in Urbana. Dr. Stevens was an authority on diseases of small fruits and the distribution of plant diseases, and contributed the comment on disease-free ornamental plants on page 218 of this issue.

Andrey Avinoff, 65, Russian-born entomologist, died July 16 in Doctors Hospital, New York City. Before he left Russia, Dr. Avinoff had made a collection of 80,000 butterflies, which are now in the Leningrad Zoological Museum. He served as director of the Carnegie Museum in Pittsburgh from 1926 to 1945, when he retired as director emeritus.

Roland G. D. Richardson, 71, mathematician and dean emeritus of the Brown University Graduate School, died at his home in Nova Scotia on July 17. Dr. Richardson retired in 1948 after 41 years at Brown. He was secretary of the International Congress of Mathematicians, which will hold its first session in this country next year.

Pedro N. Ortiz, 62, died August 4 at Mount Sinai Hospital, New York City, where he had been senior assistant clinician and advisor on tropical diseases for 12 years. Dr. Ortiz was former Commissioner of Health of Puerto Rico and during his administration established a Bureau of Uncinariasis to carry on the work of prevention and treatment of hookworm begun by Bailey K. Ashford of the U. S. Army Medical Corps.

José Kabigting Santos, 60, retired professor of botany, University of the Philippines, died August 6, at the Quezon Institute, Quezon City, Philippines, following a long illness. Dr. Santos was one of the pioneers in investigating sex inheritance in plants. He was the first president of the Philippine Scientific Society.

Recently Received—

International Conference on the Physics of Metals. (Sponsored by the International Union of Pure and Applied Physics and Netherlands Physical Society. Held in Amsterdam, 12–17 July 1948.) Published by Martinus Nijhoff, The Hague, Netherlands.

Problems of Early Infancy: Transactions of the Second Conference, March 1–2, 1948, New York City. Milton J. E. Senn, (ed.). Available from the Josiah Macy, Jr. Foundation, 565 Park Avenue, New York 21, N. Y. at $1.00.

Speciation in Salamanders of the Plethodontid Genus Ensatina by Robert C. Stebbins. (Univ. California Publs. in Zoology, Vol. 48, No. 6.) University of California Press, Berkeley and Los Angeles, California. $2.50.

Cultural Relations between the United States and the Soviet Union: Efforts to Establish Cultural-Scientific Exchange Blocked by U.S.S.R. (Dept. of State publ. 3480.) Supt. of Documents, U. S. Govt. Prntng. Office, Washington 25, D. C. Price 10¢.

Law and Government of the Grand River Iroquois by John Noon. (Publ. 12.) The Viking Fund, Inc., 14 East 71st Street, New York 21, N. Y. $2.00.

Fatty Acid Antibacterials from Plants by H. A. Spoehr *et al.* (Publ. 586.) Carnegie Institution of Washington, Washington 5, D. C. 50 cents paper, 75 cents cloth.

The Sixth Semiannual Report of the U. S. Atomic Energy Commission, submitted to Congress July 30, is a 203-page summary of the major developments in all phases of the AEC program. Weapons continue to be the central project, and increasing attention is being given to reactor development. But reports on programs in biology and medicine are broader than the others because much of the information in those fields is unrestricted. There are, for example, sections on acute radiation illness and burns, radiation and heredity, medical effects of the explosions over Hiroshima and Nagasaki, radioactive wastes, cancer research, and radiation and agriculture. The report is available under the title *Atomic energy and the life sciences*, from the Government Printing Office for 45 cents.

The Health and Safety Division of the U. S. Bureau of Mines has established a roof control section in an effort to overcome the hazards of falling rock and coal, which kill six times as many miners as explosions do. Headed by Edward M. Thomas, mining engineer, the new section will also study the adaptation of suspension roof support to more general use in mining and will provide consultation services to mine operators.

The Royal Society Scientific Conference: Report and Papers Submitted, PB 98072, a 723-page review of the problems involved in the publication of research, is available at $6.00. Sections of the report are devoted to publication and distribution of reports of original work; abstracting services; indexing and other library functions; and the preparation of reviews, annual reports, and related documents. ***A List of Periodicals and Bulletins Containing Abstracts Published in Great Britain***, PB 98072-S, has also been prepared by the society's Abstracting Services Consultative Committee, and is available at 80 cents. Both reports may be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Checks should be made payable to the Treasurer of the United States.

Make Plans for—

Meteoritical Society, 12th annual meeting, September 6–7, University of Southern California, Los Angeles.

American Congress of Physical Medicine, September 6–10, Netherlands Plaza Hotel, Cincinnati, Ohio.

American Physiological Society, fall meeting, September 14–17, Sheraton Bon Air Hotel and School of Medicine, University of Georgia, Augusta.

The Maximum Efficiency of Photosynthesis: A Rediscovery

Dean Burk, Sterling Hendricks, Mitchell Korzenovsky, Victor Schocken, and Otto Warburg

National Cancer Institute, National Institutes of Health, U. S. Public Health Service, Bethesda, Maryland; Plant Industry Station, U. S. Department of Agriculture, Beltsville, Maryland; and *Marine Biological Laboratory, Woods Hole, Massachusetts*[1]

IT WAS REPORTED in 1923 (*4*) that in photosynthesis 4 light quanta, absorbed by chlorophyll in green cells, can produce one molecule of oxygen under favorable conditions. This means that with red light about 65 percent of the absorbed radiant energy can be transformed into chemical energy. Quanta of red light are of low energy (~ 44,000 cal/mole) and several such quanta must therefore cooperate to develop one molecule of oxygen, which requires ~ 112,000 cal/mole. No analogy is known in the nonliving world, where most photochemical reactions, although simpler and effected by quanta of higher energy, are far less efficient in energy transformation, and are indeed usually exothermic. It became clear that an unknown principle, active in nature, awaited elucidation by physics and chemistry.

It is well known how the anticipated study of this new principle was interrupted about 1938, when almost every investigator in the field came to accept as the maximum efficiency of the energy transformation low values of 20 to 25 percent, that is to say, quantum values of 10 to 12 with red light. The development of this revocation has been extensively summarized in a book just published in the last few months by James Franck and Walter Loomis (*1*) and contributed to by a series of investigators.

We have reinvestigated the problem and have rediscovered the high efficiency of energy transformation in photosynthesis. The data obtained are conclusive.

In the course of this reinvestigation the methods have been simplified and improved in such a way that determinations of quantum requirements are no longer the privilege of the few. On the contrary, anyone who has a suitable light source and simple manometric equipment can now determine quantum requirements and convince himself that in green cells the greater part of the absorbed light energy can be transformed into chemical energy (see Addendum).

IMPROVEMENTS IN TECHNIQUE

Culture of cells. A strain of *Chlorella pyrenoidosa*, used in various institutes for many years and originally isolated and identified by Florence Meier, of the Smithsonian Institution, was cultivated in 300-ml gas wash bottles of the Drexel type. The culture medium was 5 g $MgSO_4 \cdot 7\,H_2O$, 2.5 g KNO_3, 2.5 g KH_2PO_4, 2 g NaCl, and 5 mg $FeSO_4 \cdot 7\,H_2O$, dissolved in 1000 cm³ of nonsterilized well water (pH 4.5 to 5.0). Approximately 100 mm³ of cells suspended in 200 cm³ culture medium was added to each bottle, and aerated with 5 percent CO_2 in air so rapidly (~ 500 ml/min) that no sedimentation of the cells occurred. They were illuminated with a 100-w incandescent lamp that raised the temperature in the bottles to 25–30° C. After several days, when the cells had multiplied several fold, and the pH had risen 0.5 to 1 unit, the cultures were used for yield experiments. Such cells gave stable respiration values and high yields without exception. This culture method, which had been employed by one of us (D.B.) for many years in Washington, was found to be an important improvement over the method of 1923 (*4*) followed by most later investigators but which we have now discarded. In the earlier method, slowly aerated cells settled down in Erlenmeyer flasks in sediments that were inade-

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[1] We wish to acknowledge the facilities and laboratory accommodations for research and demonstrations provided at the Marine Biological Laboratory by Professor E. S. Guzman-Barron and by Dr. Charles Packard, Director. Valuable aid in these investigations was provided by Mrs. Lois H. Macri, Mrs. Clara F. Smith, and C. R. Newhouser. The culture of *Chlorella pyrenoidosa* was obtained from Dr. F. E. Allison of the Plant Industry Station, U. S. Department of Agriculture, Beltsville, Maryland. We wish to thank E. Machlett and Son, New York City, for special facilitation of provision of the manometric glassware, and the American Instrument Company, Silver Spring, Maryland, for the specially adapted thermostat and shaking mechanism employed.

quately illuminated and inadequately supplied with carbon dioxide and oxygen until reshaken up.

Manometry. Approximately 300 mm^3 of cells, resuspended in 7 cm^3 of a fresh culture medium of pH 4.9, were put into rectangular vessels of 14 to 20 cm^3 volume and saturated with 5 percent CO_2 in air. Two vessels were used to determine, as described in 1924 (*3*), the oxygen as well as the carbon dioxide exchange. The gas volumes in the two vessels were different, but the volumes of the solutions and therefore the concentrations of the cells were equal. The vessels were shaken at 20° C by horizontal motion, with an amplitude of 2 cm and a frequency of 150 per min. In spite of this rapid motion, which moved the vessels 600 cm per minute, no splashing or foaming occurred, even in experiments of more than 20 hr duration. It was a further improvement owing to this motion that physical transition effects were not observed upon change from dark to light and vice versa, that is, the gas equilibration was virtually perfect for our purposes.

The well known requirement of the two-vessel method, that the metabolism in the two vessels must be identical ($x_{O_2} = x'_{O_2}$ and $x_{CO_2} = x'_{CO_2}$) was complied with by eliminating a dangerous differential time factor as nearly as possible. The light beam of measured intensity (630 to 660 mμ) was shifted by a mirror alternately from one vessel to the other at intervals of 10–60 min or these vessels were shifted alternately into and out of the fixed light beam. Thus in every case the one vessel was illuminated when the other vessel was dark and vice versa, and when many light and dark periods followed each other and the pressure changes of all dark periods and of all light periods were summed, the metabolism in the two vessels was virtually identical for the same periods of elapsed time. The total pressure changes effected by light were usually of the order of magnitude of + 20 to + 50 mm. These figures were differences between two rates of oxygen consumption (negative pressure changes) in the experiments with noncompensated respiration. But when the respiration was compensated by white light (see following section) the figures + 20 to + 50 mm were the directly observed positive pressure changes, produced by the added red light. To measure such great pressure changes, simple Haldane-Barcroft blood-gas manometers could be used instead of the special differential manometer heretofore employed.

Measurement of the quantum intensity. The bolometer used in 1923 was replaced by the chemical actinometer described a few months ago (*6*). This resulted not only in a simplification but in an improvement in accuracy. When the oxygen produced by the red light had been measured, the vessel containing the cells was replaced by a similar vessel containing 2 mg of ethyl chlorophyllide, 200 mg of thiourea and 7 cm^3 of pyridine, with tank oxygen as the gas phase. The light absorption being complete in the cell suspension as well as in the ethylchlorophyllide solution, the quantum requirement per molecule oxygen was obtained by the very simple equation:

$$\frac{1}{\phi} = \frac{h \cdot \nu}{O_2} = \frac{O_2 \text{ consumed by the actinometer}}{O_2 \text{ produced by the cells}},$$

where the consumption and the production of the oxygen must be calculated for equal time periods.

Complete absorption is the only method so far devised by which the *absorption* of the light and the *action* of the light can be measured manometrically under the same conditions. Thus far all manometric determinations of quantum requirements using incomplete absorption are contradictory and uncertain. On the other hand, the main objection against the method of complete absorption was the existence of too great a respiration relative to the measured light action; this objection is no longer valid because today respiration can be eliminated by compensating with white light or components thereof (see the following section).

A NEW PRINCIPLE

Let us consider a *Chlorella* suspension, shaken in a beam of red light that is absorbed completely, to be a machine that transforms light energy into chemical energy. The efficiency of this machine will be known if we know the light energy entering the vessel and the amount of oxygen developed in it, one mole of oxygen being equivalent to the production of about 112,000 cal. No theory of the mechanism of this energy transformation can alter the observed result of such an efficiency determination.

Yet there are possible objections to be answered. When at low light intensities respiration still exceeds photosynthesis, then our machine does not produce a net gain of chemical energy, and it might be considered that the light merely inhibits the loss of chemical energy. Since respiration is a catalytic process, conceivably its inhibition by light could be merely anticatalytic, requiring no expenditure of energy. Hence the calculation of the efficiency might be safe thermodynamically only when the light intensities are so high that oxygen is in fact given off from the cell suspensions into the gas space.

To comply with this requirement we illuminated the cell suspensions with white light (of nonmeasured intensity) over the greater part of the vessel surface, the light intensity per unit area being relatively small, but the influx of light energy through the total area of the vessel being sufficient to compensate or overcompensate the respiration of the cell suspensions. As the compensating light intensity we define here that light intensity which effects the result that no oxygen enters or leaves the cell suspension. It is very likely that in this state the oxygen exchange of all cells in the suspension is zero, owing to the rapid motion of the cells. It is obvious that our compensating light intensity varies with the amount of cells in the vessel and is not to be confused with the compensating light intensity for very thin cell suspensions.

When the steady state in the white light was reached, a beam of red light of measured intensity was sent through the bottom of the vessel into the cell suspension, the cross section of the beam being 3 cm^2 and the total energy flux about 0.25 microeinsteins/min. It was completely absorbed in the cell suspension. The increase of positive pressure effected by the red light and the intensity of the red light were the two magnitudes from which the efficiency of the energy transformation of the added red light was calculated. The efficiency so found with red light proved to be as high, at and several fold above the compensation point with white light, as the efficiency at zero or low white light intensities below the compensation point (3 to 5 quanta per O_2 molecule developed; see Examples 1–5).

This result raised the whole level of certainty in this field of investigation, and is probably owing in large part to the rapid motion of a great amount of cells. The time of illumination with red light of relatively high intensity must be so short for every cell that no Blackman or other dark reaction limits the action of the light; in other words the product of light intensity and time $(i \times t)$ must be too small to alter the concentrations of dark reactions. The observed efficiency is, of course, a fact that is independent of all theories about what happens in the cell suspensions, chemically or physically.

Another factor that might limit the certainty of efficiency determinations is time of illumination. The shorter the time periods, the greater is the danger that the energy of some dark reaction contributes to the oxygen production. The longer the time periods, the more certain are we that we have reached the thermodynamically desirable state in which the concentrations of all cell constituents are kept constant.

From 10 min in 1923 (*4*) and 15 min in 1948 (*5*) we have now extended the time periods to more than 20 hr of continuous illumination with white light, producing continuous positive pressure, and have varied the periods of the efficiency determinations with added red light from 5 to 60 min. This great improvement was possible because the horizontal motion of the rectangular vessels did not damage the photosynthetic capacity of the cells and because the white light, when it overcompensated respiration, stabilized the chemical conditions in the cells. In fact, the efficiency of the energy transformation has now been measured under the conditions of growth, so that very likely the experiments can be extended to any length of time.

NONACTION OF LIGHT ON RESPIRATION

If the manometric efficiency of the red light is the same when the respiration of the cell suspensions is noncompensated, compensated, or several fold overcompensated by added unmeasured white light, then obviously every theory should be rejected that assumes that light acts on the process of respiration anticatalytically or stoichiometrically. This conclusion has now been confirmed independently by the following type of experimentation:

A rectangular vessel was set up to contain NaOH and glass beads in two side arms, 300 mm^3 of cells in 7 ml of culture medium (pH 4.5–5) in the main compartment, and air in the gas phase. The vessel was shaken at 20° C slowly or rapidly, and in the dark or in the light. By changing the rate of shaking the steady-state pressures of CO_2 in liquid and gas phases were changed, but in the dark this had no effect on the observed rate of respiration. In the light, the rate of oxygen consumption decreased in the slowly shaken vessel; but in the rapidly shaken vessel, where the steady-state pressure of CO_2 was lower, *no action of light on the rate of oxygen consumption was observed* when the intensity of the light entering the vessel was about 0.25 microeinsteins/min, an intensity that with adequately high CO_2 pressures gave high photosynthetic efficiencies (3 to 5 quanta per molecule of O_2 developed). The shaking effect was reversible, the action of the light alternately appearing or disappearing with decreasing or increasing shaking rate.

The experiments may be extended to higher light intensities, but the higher the light intensity the more effective must be the removal of the carbon dioxide, for which the light and the alkali compete. The CO_2 pressure required to yield maximum respiration is clearly below that needed for effective photosynthesis, where CO_2 functions as substrate and not merely catalytically.

Such experiments prove that the light did not interfere with the process of respiration, either anticatalytically or stoichiometrically by reduction of intermediates. Light, when it compensated respiration, did so by producing oxygen, and because the gas exchange of photosynthesis happens to be the reverse of the gas exchange of respiration. Thus a question, old as the science of photosynthesis, has been answered by the most simple of experiments.

EXAMPLES

1. Manometric pressure changes effected by red light when respiration was not compensated by white light. Two-vessel method, culture medium pH 5, 5% CO_2 in air. 20° C.

Vessel I $v = 13.913$, $v_f = 7.00$

Vessel II $v' = 17.093$, $v'_f = 7.00$

Actinometer 5.4 mm³ O_2/min

Vessel I	Vessel II
10 min dark − 26 mm	10 min dark − 12 mm
" " " − 23 "	" " " − 10 "
" " " − 23 "	" " " − 11 "
" " " − 23 "	" " " − 11 "
40 min dark − 95 mm	40 min dark − 44 mm
10 min light − 17 mm	10 min light − 7 mm
" " " − 15 "	" " " − 7 "
" " " − 14 "	" " " − 7 "
" " " − 15 "	" " " − 7 "
40 min light − 61 mm	40 min light − 28 mm
Light action + 34 mm	Light action + 16 mm

$$\left.\begin{array}{l} x_{O_2} \text{ in 40 min } + 51.6 \text{ mm}^3 \\ x_{CO_2} \text{ in 40 min } - 53.7 \text{ mm}^3 \end{array}\right\} \gamma = \frac{CO_2}{O_2} = -1.04$$

$$\frac{1}{\phi} = \frac{h\nu}{O_2} = \frac{40 \cdot 5.4}{51.6} = 4.2$$

2. Manometric pressure changes effected by red light at 20° C, when respiration was overcompensated by white light. pH 5.0. 5% CO_2 in air. Actinometer for red light 5.4 mm³ O_2/min.

Vessel I $v = 13.913$, $v_f = 7.00$

Vessel II $v' = 17.093$, $v'_f = 7.00$

Vessel I

5 min white + 18.5 mm	5 min white + red + 22 mm
" " " + 18.0 "	" " " " + 22.5 "
" " " + 16.5 "	" " " " + 22 "
" " " + 17.5 "	" " " " + 20.5 "
" " " + 17.0 "	" " " " + 23.0 "
25 min white + 87.5 mm.	25 min white + red + 110 mm.

Action of red light + 22.5 mm in 25 min.

Vessel II

5 min white + 14 mm	5 min white + red + 15 mm
" " " + 14 "	" " " " + 16.5 "
" " " + 12.5 "	" " " " + 16.5 "
" " " + 14.0 "	" " " " + 14.0 "
" " " + 11.5 "	" " " " + 15.0 "
" " " + 12.0 "	" " " " + 14.5 "
30 min white + 78 mm.	30 min white + red + 91.5 mm.

Action of red light + 13.5 mm in 30 min.

$$\left.\begin{array}{l} x_{O_2} \text{ in 25 min } + 30.3 \text{ mm}^3 \\ x_{CO_2} \text{ in 25 min } - 27.2 \text{ mm}^3 \end{array}\right\} \gamma = \frac{CO_2}{O_2} = -0.9$$

$$\frac{1}{\phi} = \frac{h\nu}{O_2} = \frac{25 \cdot 5.4}{30.3} = 4.5$$

For the same culture, when the respiration was not compensated by white light, we obtained

$$\frac{1}{\phi} = \frac{h\nu}{O_2} = \frac{60 \cdot 5.4}{70.4} = 4.6$$

$$\text{and } \gamma = \frac{CO_2}{O_2} = -0.8$$

3. Manometric vessels continuously illuminated for 27 hr by white light of approximately compensating intensity. $\frac{1}{\phi} = \frac{h\nu}{O_2}$, *for the added red light*, at the beginning and end of the experiment.

In hours 1 to 4, respiration compensated, $\frac{1}{\phi} = 4.5$ ($\gamma = -1.0$)

In hours 20 to 22, respiration compensated, $\frac{1}{\phi} = 4.5$ ($\gamma = -1.0$)

In hours 27 to 28, respiration not compensated, $\frac{1}{\phi} = 3.5$ ($\gamma = -1.27$)

4. Comparison of same culture in M/10 carbonate buffer (pH 9) and in culture medium (pH 5).*

Red light, 630–660 mμ. $I \sim 0.25$ microeinsteins/min 20° C.

Quantum requirement $\frac{1}{\phi} = \frac{h\nu}{O_2}$ for the added red light.

In carbonate buffer, respiration compensated by white light, $\frac{1}{\phi} = 10.5$

In culture medium, respiration compensated by white light, $\frac{1}{\phi} = 3.9$ ($\gamma = -1.04$)

In carbonate buffer, respiration not compensated $\frac{1}{\phi} = 9.8$

In culture medium, respiration not compensated $\frac{1}{\phi} = 3.6$ ($\gamma = -1.18$)

In carbonate buffer, respiration not compensated $\frac{1}{\phi} = 11.3$

* It may be gathered from this example that the efficiency in the unnatural carbonate buffer is only a fraction of the efficiency in culture medium. Many investigators believed that the efficiencies in both solutions were equal, and this was one *of the reasons why the quantum requirement of 4* was denied by them and the figures 10 to 12 accepted as maximal.

5. Results by 2-vessel method for a series of experiments that were carried out from May 20 to June 16 of this year, at 20° C, in culture medium at pH 5, with an intensity of red light not exceeding 0.25 microeinsteins/min. No experiment is omitted.

	$\frac{1}{\phi}$	γ
	$\left[\frac{h\nu}{O_2}\right]$	$\left[\frac{CO_2}{O_2}\right]$
	3.2	− 1.08
	4.6	− 0.80
	4.5	− 0.90*
	3.9	− 1.04
	3.6	− 1.18
	4.2	− 0.97
	2.8	− 1.16
	2.8	− 1.23
	2.5	− 1.25
	4.5	− 1.00†
	4.7	− 0.93†
	3.5	− 1.27
	4.2	− 1.00
	3.0	− 1.33
Average	3.7	− 1.08

* Respiration overcompensated by white light from above.

† Respiration compensated by white light from above.

It may be gathered from Example 5 that the quantum requirement for carbon dioxide consumed can be equal to or somewhat greater or smaller than the requirement for oxygen produced. For we have

$$\frac{1}{\phi}\cdot\frac{1}{\gamma}=\frac{h\nu}{O_2}\cdot\frac{O_2}{CO_2}=\frac{h\nu}{CO_2},$$

a magnitude which here for the first time, to our knowledge, has been determined in nutrient medium at low pH (about 5), and has been found to approximate $\frac{h\nu}{O_2}=3$ to 5.

Yet the quantum requirement for oxygen is the more fundamental energy measure, because there is only one reaction in photosynthesis that produces oxygen—the photochemical reaction (decomposition of water); but there are many different dark reactions that consume carbon dioxide to form a great variety of products. Thus if, as an extreme case, oxalic acid were formed from water and carbon dioxide γ for this compound would be -4 and the quantum requirement for carbon dioxide would be only one-fourth of the requirement for oxygen.

CONCLUSION

It follows from the data obtained[1] that in the spectral region 630 to 660 mμ no more than 4 quanta are required to produce one molecule of oxygen gas. A requirement of 3 quanta is open to serious consideration, although thus far the average value in our experiments has been nearer 4 than 3.

A quantum requirement of 4 means that the efficiency of the energy transformation in our experiments was approximately $\frac{112{,}000\times 100}{4\times 44{,}000}=65$ percent, whereas the quantum number 3 would mean an efficiency of about 85 percent.

In any event, under favorable conditions the greater part of absorbed light energy can be transformed in green cells into chemical energy, and this is, to quote the man who laid the foundation of quantitative photochemistry, "a marvellous achievement of nature" (*2*).

ADDENDUM

Quantum requirement determinations were demonstrated to, and carried out with the aid of, the students of the physiology class at the Woods Hole Marine Biological Laboratory on July 19 and 20. Requirements of 3 to 5 quanta per molecule of oxygen gas produced in photosynthesis were observed on these two days. The respiration was overcompensated several fold by light of unmeasured intensity from an incandescent lamp used with or without red filter (cutoff at ≦ 560 mμ). In two closely comparable, consecutive experiments, quantum requirements of 3.0 and 3.5 were obtained from measured red light (630–660 mμ) when the overcompensating light entered the manometric vessel as, respectively, white light from above and filtered red light from below. In the latter instance the cells mainly responsible for overcompensation by unmeasured light were identical at any given moment with those receiving the added measured red light. The absorbed measured red light was but a fraction of the total energy flux absorbed, most of which was absorbed in the first millimeter of depth. The aid of students Jack Durell, Richard Klein, Burlyn Michel, and Martin Schwartz in carrying out various of the class experiments is acknowledged gratefully.

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[1] Reported in greater experimental detail in *Biochem. et Biophys. Acta*, October 1949 (Meyerhof-Festschrift volume); *Arch. Biochem.*, September 1949; and at meeting of Society of General Physiology, Woods Hole, Massachusetts, June 1949.

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Scientific and Industrial Research in Britain

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THE PROBLEM of government help for science in industry is to secure the advice of both science and industry on what is needed, and then to combine reasonable continuity with some broad measure of democratic control. Like other problems of organization which are a little out of the ordinary, it has been handed in Britain to the Privy Council.

This is a centuries-old body which derives its authority directly from the King, and so carries weight; and as it is a purely formal body with no well-defined terms of reference it can conveniently concern itself with this problem. It is the Privy Council which nominally runs Britain's Department of Scientific and Industrial Research for the King. But the £4,199,625 which is the department's estimated expenditure for 1949–50 is provided in the normal way by Parliamentary vote, and the Lord President of the Council, chief of the Privy Council, is a cabinet minister. The advantage of the Privy Council connection is that it provides an administrative umbrella for an advisory council which is genuinely active. This consists of a mixture of outside scientists and industrialists, particularly those connected with industrial research, with two trade unionists as a more recent addition. The secretary of this advisory council is the permanent head of the department—at the present time Sir Ben Lockspeiser.

Of the department's staff of 3,200, more than 1,900 are engaged in research or technical work, including the supply of information. The department has twelve research stations of its own, supports some forty cooperative research associations, which among them cover the greater part of British industry, and by a system of grants encourages what it considers promising research at universities. Finally, through its headquarters, the department aims to act as a general clearing house for the exchange of scientific information of interest to industry; and with the same object, research associations are being encouraged to provide sufficient outside staff to bring information, and the means for information, directly to individual firms. No one and no organization can be omniscient, but an efficient information service can and should know where up-to-date information is to be found—whether in print or from someone who knows.

GAPS IN RESEARCH

The main job of a research department is to fill gaps in research. Such gaps may be of different kinds and arise for different reasons. One is where the cost and size of certain equipment are greater than could be afforded without the help of the department. This is true of the wind tunnels used for the study of airflow and the design of aircraft, and the two 650-foot ship tanks at the National Physical Laboratory, Teddington, London. Both are competitively necessary for the industries they serve, not only for testing particular designs, but even more for the building up of a secure foundation of knowledge on which advances in design can be based.

The National Physical Laboratory is also responsible for maintaining national standards of length, weight, and so on. This is not research in the ordinary sense, but it involves research, and is of direct importance to industry, for in the long run all accurate measurements of whatever kind go back to laboratory standards.

A second kind of gap is where the demand for improvement comes from the user, rather than from manufacturer or producer. An example is the work of the chemical research laboratory of Britain's Department of Scientific and Industrial Research on the corrosion of metals. The laboratory is at the present time studying the thin surface films which give metals protection, and its work on the corrosion of iron pipes by bacteria in certain types of soil may well repay the running costs of the laboratory for all time. The chief users in this case are water supply undertakings, for the most important buried pipes are water mains.

In the case of noise, the user is anyone whose home is in a block of flats. This problem is a special case of the replacement of traditional methods of building by others less extravagant in time and materials, and the basic research on accoustics is undertaken at the National Physical Laboratory.

FOOD REFRIGERATION

Research on the storage and transport of food is also in the ultimate interest of the British public as eaters of the food. The older side of the department's work was on low temperature storage, and its principal laboratories were at Cambridge, Aberdeen (for fish), and at East Malling in southeast England (for fruit). Examples of practical achievement have been the refrigerated gas storage of fruit and meat. A pest infestation laboratory was established in 1939, at a time when the government was much concerned over the wartime conservation of the nation's food stocks, chiefly grain. Since it is now a world, as well as a national, problem to obtain the best use from available food resources, it is probable that work on these lines will continue permanently.

The Forest Products Research Laboratory at Princes Risborough, near London, is used by interests in Britain, although it works closely, too, with the forestry departments of overseas territories on the suitability of particular timbers for various uses. It is concerned with the seasoning and preservation of timbers, as well as with their properties, and its work has been considerably increased by the wide use recently of substitute timbers.

The Building Research Station at Watford, near London, has played a large part in British postwar housing plans by working out standards of construction and methods of testing. It is a "user" laboratory, in the sense that neither individual local authorities nor small builders could be expected to carry out the necessary research if left to themselves, and it is directly in the interests of the householder that this research should be carried out.

FUEL AND RADIO RESEARCH

A third category of research is that directed to the best use of any national asset too important to be left to take its chance. The outstanding example in Britain is that of coal—and this brings in the Geological Survey, in the finding of coal and the collection of samples for examination; the Fuel Research Station at Greenwich, London, on the properties of different coals and their efficient use; and the Building Research Station, on domestic heating.

Other laboratories, which have not been mentioned, deal with road research and river pollution. Radio, and particularly radio propagation, is an old interest in the department which has already paid dividends in the development of radar and the use of radio methods in weather forecasting. Radio research, generally, is at present divided between the National Physical Laboratory and a small subsidiary station near Slough, outside London. A site is being sought for a new station at which the department's radio work can be centralized. A second new station, for work on mechanical engineering, is already being built at East Kilbride, near Glasgow, and a third for work on river and harbor models will be built when a suitable site is found.

All these activities are designed to close gaps which, it is felt, can be best closed by government action. And the search for such gaps continues. At the present time a committee is considering needs for research in chemical engineering. Finally, it may again be emphasized that all these institutions are centers of information as well as of research. They are collections of experts as well as of machines and equipment. And they are at the service of other government departments, cooperative research associations, and individual private firms which may have problems to present, with the intelligence division of headquarters as a general signposting unit.

TECHNICAL PAPERS

Qualitative Differences of Malignant Tissue

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Recently, Carruthers and Suntzeff (*2*, *3*) have published two important papers. Based on polarographic investigations, they conclude that, in opposition to the current view, certain tumor lipids show qualitative[1] differences from those in normal tissues. These lipids seem to arise at the moment of carcinogenesis, for in the preparative stages no differences are observed. They are soluble in alcohol-ether mixtures; probably they are bound to proteins.

We would like to draw attention to the fact that, long ago, several immunologists (the field of cancer immunology seems to be somewhat neglected in recent years) showed that there exists a true tumor antigen of lipid character, which is able to incite the formation of specific antibodies in the rabbit, though only in a few animals (Hirsfeld and his school—1931 *et seq.*).

We will also refer to the early paper by Waterman and de Kromme (*6*) (1929) wherein it was shown that isolated suspended tumor cells are agglutinated by the sera of animals, not belonging to the Forssman group on account of their containing a specific antigen, but probably related to the heterogenetic Forssman antigen. De Kromme (4) has prepared specific antisera by injecting rabbits with carefully washed tumor cells; these antisera react with a precipitation reaction with the lipid tumor antigen excreted with the urine. This observation has been made the base of a diagnostic reaction in the first specific ethers of cholesterol.

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[1] In a nature-philosophical sense there exist, of course, no qualitative differences, since all matter is built up from the same element in varied distribution.

As to the chemical nature of the antigen, Kolodziejska and Halber (5) and Breinl and Chrobok (1) have investigated this by means of complement-fixating tests with the sera of immunized rabbits. Kolodziejska and Halber assume that fatty substances are the specific substance, or that in any case the specific substance is carried with the fatty acids. Breinl and Chrobok locate the antigen in specific ethers of cholesterol.

In the last few years we have renewed our attempts at isolation of this antigen. An example of our recent procedure is offered here. We must confess, however, that so far we have not been able to isolate a substance with a well defined melting point, although we have arrived at a fraction, of which 0.1 µg reacts promptly with precipitation in the form of a ring test when brought in contact with the immune serum.

Perhaps the communication of our procedure may help other investigators to define the nature of the lipid. If so, we believe that an important piece of work will have been performed. In any case, the agreement of polarographic investigations with serological results would be very gratifying.

Case II. Over a period of a week 1100 g of metastatic liver tumor (carcinoma mammae) is extracted with 11 l alcohol, 96% acidified with 10 cc HCl 7 N at 37° C, under frequent stirring.

After filtration, the alcohol is distilled off and the watery residue (*plm.* 1 l) is extracted during 48 hr with a 50% mixture of ether and petrol-ether. The ethereal extract is evaporated to 150 cc and brought to 1 l with acetone. The precipitated phospholipids are filtered off, and the yellow filtrate is evaporated *in vacuo*. The resulting brown oily residue is stirred with 1 l 1% natrium carbonate (pH 9.5). This yellow soap is extracted during 48 hr with ether. The watery solution is brought to pH 3 with 30 cc HCl 25% and the acid solution is extracted again with ether. This ethereal extract is brown.

After evaporating off the ether in nitrogen atmosphere, there remains 8.5 g of a dark brown oil. This is solved in 800 cc alcohol 96% at 70° C. To this solution a boiling clear solution of 5 g lead acetate in alcohol is added; the lead salts of the higher saturated fatty acids are precipitated. After 12 hr standing, these are filtered off on a Büchner funnel. A stream of H_2S is conducted into the clear yellow filtrate containing the soluble lead salts, and the lead sulfide is removed. After evaporation of the yellow filtrate in nitrogen atmosphere the resulting red-brown oil is suspended in 800 cc 12½% ammonia under heating to 80° C. After standing overnight, the ammonia is removed by a stream of nitrogen.

After adding 8 g of barium chloride an orange precipitate is formed, which is washed with water. The precipitate is solved in 80 cc 10% HCl and extracted again with ether. After evaporation (residue: 4½ g) the extract is solved in petrol ether (40–60° C) in order to remove any hydroxy-acids that may be present, and filtered. The solution is agitated with water, dried again, and dissolved in 50 cc dry acetone. The insoluble fraction is filtered off and washed with cold acetone. The brown acetonic solution is cooled for ½ hr at −20° C and the precipitate is rapidly centrifuged in cooled tubes. The precipitate (130 mg) proves highly active in the immunological test (ring reaction with cancer immune serum).

The same treatment is repeated. The rose-colored precipitate is solid at room temperature (26 mg). It is soluble in warm, dry, alcohol-free ethyl acetate: by cooling at 6° C and centrifuging a white precipitate is formed; the ethyl acetate is yellow.

This treatment is repeated four times; now the filtrate is colorless. The precipitate is dried *in vacuo* and becomes slightly brownish thereby. Melting point 100–130° C.

The treatment with barium chloride is repeated, followed by the ethyl acetate procedure described. The resulting precipitate is highly active. One-tenth µg is active in a concentration of 1: 1,500,000.

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A One- and Two-dimensional Paper-Partition Chromatographic Apparatus

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The ascending force of capillary action for chromatographic separation, reported earlier by Williams and Kirby (1), has been used in the apparatus to be described here. The apparatus (Fig. 1) consists of a 1-liter graduated cylinder, a No. 13 rubber stopper, some adhesive cellophane tape, and a stainless steel paper holder constructed from two flat and open coils, 60 mm in diameter, and two rods or tubes, 340 and 400 mm in length. Each of the two coils is made from a piece of stainless steel wire or tubing 432 mm in length and 2 mm in diameter. Both ends of the piece of wire or tubing are flattened and fashioned into loops. The longer rod is passed through the inner loop of the lower coil and is permanently attached to it vertically at a point 25 mm from the lower end. The shorter rod is permanently attached at one end of the outer loop of the lower coil so as to be parallel to the other rod. The two rods are passed through the corresponding loops of the upper coil but are not fastened to them. Since the upper coil can be raised or lowered, it is possible to use sheets of paper of different size, up to 350 mm square. A paper sheet is loaded conveniently by threading it through the coils with a gentle rolling motion.

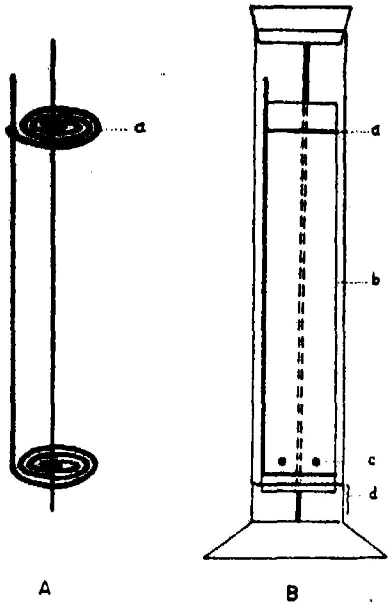

FIG. 1. Chromatographic apparatus. A—Paper holder with adjustable coil (a). B—Assembled apparatus, showing adjustable coil (a), paper (b), position of test spots (c), and liquid volume (d).

Chromatograms are usually run on sheets of filter paper 300 to 330 mm long and 230 to 280 mm wide. For one-dimension chromatograms, both the standard and unknown solutions are pipetted onto the paper at a distance of 25 mm from the bottom of the sheet. The liquid usually covers an area 3–5 mm in diameter. After the spots have dried, the paper is rolled into the paper holder. The paper should extend about 10 mm below the lower coil and about 25 mm above the upper coil. The loaded paper holder is quickly placed in a 1-liter cylinder, containing 100 ml or less of solvent, with about 10 mm of the lower edge of the paper in the solvent. The cylinder is closed with the rubber stopper and if it has a lip the hole is sealed with adhesive cellophane tape. The liquid is allowed to ascend by capillary action for a fixed period of time. After expiration of the allotted time, the chromatogram is removed from the cylinder and dried in a stretched horizontal position and then analysed according to the particular method in use.

For a two-dimension chromatogram, a single spot of test solution is placed in the lower left corner of the sheet of paper, approximately 50 mm from the edges, and the sheet is then placed in the paper holder and treated as described. After expiration of the allotted time, the chromatogram is dried. The sheet is then placed in the paper holder in such a manner that the separated constituents are made to travel upward along the paper at a right angle to the direction from which they moved previously. The final chromatogram is removed, dried, and analyzed.

This apparatus has a number of advantages. It is simple in design, requires small space, and is airtight. The chamber can easily be protected from light if the compounds are light sensitive and construction can be all-glass if conditions demand.

Reference

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Note on an Index of Conformity

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An index to measure the degree of conformity to some norm, or single class interval, of a variable is here proposed. It is an improvement in percentage form of the 4th moment (in sigma units) or Pearson's beta sub-two (taken from an arbitrary origin), which Peters proposed under the label of an "index of institutionalization" (*1*). This index had grown out of studies such as those by Allport on the "J curve of conforming behavior." The formulas for our "index of conformity" (Cfy) and graphs of its behavior are given in Fig. 1. Its derivation is simply that, since the 4th moment varies from unity to infinity, its reciprocal will vary between the limits of 1 to 0. This measures nonconformity so that the complement from unity of this reciprocal is taken to measure degree of conformity. This proportion is multiplied by 100 to express it in familiar percentage units. The origin about which the moment is calculated is the norm or class interval of expected behavior, i.e., any arbitrary origin to which the degree of conformity of the data is to be tested.[1]

$$\mathrm{Cfy} = 100(1 - (\Sigma x^2)^2/N\Sigma x^4)$$

where $x = X - \text{norm}$.

This index measures the degree of concentration in, or dispersion from, one class interval which may be the norm in the social mores, or may be any class interval set up by the analyst as an hypothesis for testing the degree of conformity of the data to it. It measures kurtosis on a scale where 100% is maximum, around 67% is mesokurtic, around 50% is platykurtic, and 0% is negatively leptokurtic or maximal anticonformity.[2] In Fig. 1, the base lines correspond to the amount of conformity of each graph in the conformity scale (Cfy) at the left. Graphs are presented for the simple two-category cases of conforming or nonconforming in the first column, and for the case of five categories or class intervals of the variable in the second and third columns (which differ only in that the norm is at one extreme in the second column and is at the middle in the third column). The graphs show clearly for some common types of distributions how perfect conformity means that all the frequencies are in the norm class interval; around 50% conformity means a rectangular distribution in general, with the frequencies equally divided among all class intervals, and 0% conformity means that the frequencies are all concentrated in the class intervals furthest away from the norm. Further features of this index are seen to be that it is applicable to all shapes of distributions and that it is independent of the unit in which the variable is expressed. It is a percentage or pure number, since in its formula the dimensions of the numerator and of the denominator cancel each other out, leaving a dimensionless ratio. It thus measures conformity to a norm expressed as a percentage of maximal conformity. A further feature of this index is that in the two-category cases of conformity or nonconformity it becomes identical with the simple percentage of persons conforming, and thus is readily interpretable by laymen.

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[1] At the limit of complete conformity, when all deviations from the norm are zero, beta sub-two becomes indeterminate, needing evaluation. Aside from the mathematics of this case, its computation gives no trouble, since conformity is evidently maximal and can be so recorded on mere inspection.

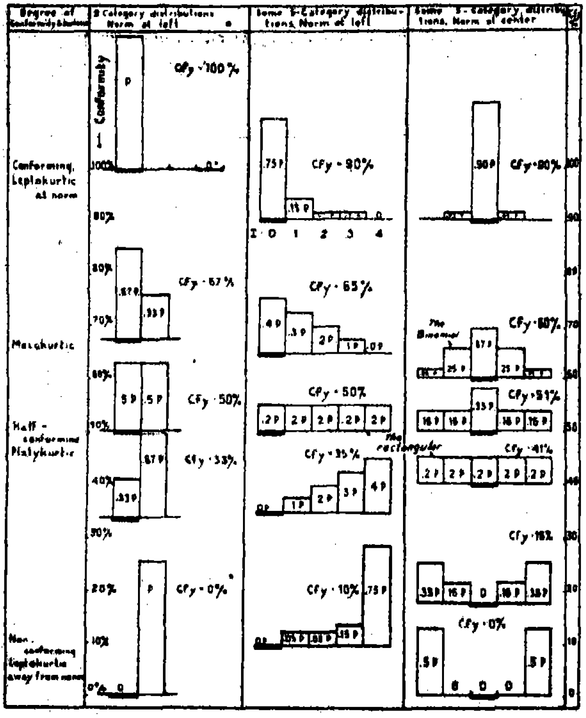

FIG. 1. Conformity distributions.

Conformity = Every person in the standard or norm class interval (underlined) which is expected by the mores. Cfy = 100%

Nonconformity = Every person furthest from the norm class interval (underlined) which is expected by the mores. Cfy = 0%

* It makes no difference whether many or no categories intervene in a two-category distribution.

Within certain limits, this conformity index indicates unimodality to bimodality. It indicates this best in symmetric distributions when the norm is central. Then a Cfy of 100% indicates perfect unimodality; while Cfy of 0% indicates perfect biomodality. Intermediate degrees of Cfy, while not measuring the tendency for the distribution to have one versus two peaks, measure the underlying tendency for the population to be concentrated around one class interval (the norm at the center) or dispersed into two concentrations around the two extreme class intervals. Cfy is not a constant measure of bimodality, since the relation of Cfy to degree of bimodality will shift with the conditions. Thus, under conditions of an asymmetric distribution with the norm not central, 0% will not indicate perfect bimodality.

As the index drops it reflects a homogeneous or unified population, becoming separated into two opposite camps with respect to the characteristic measured. Cfy thus can measure the degree of enmity or opposition of two groups along a given dimension. Cfy does not measure the dichotomizing of a group into two camps under all conditions; rather it measures the conformity or absence of deviation of a group from a norm.

This index should have wide usage and great convenience in sociology, psychology, and other fields in measuring the degree of deviation from some expected behavior or conditions wherever that is one of two or more possible class intervals of such behavior or conditions. It can crucially test hypotheses.

For judgments of sampling reliability, one may use the standard error of the 4th moment, whether calculated about the mean or about an arbitrary origin. For large samples, this is the usual $\sigma^4\sqrt{96/N}$. Or one may use the standard error of beta sub-two about an arbitrary origin.

For an example of its use, Peters' data of automobile drivers keeping in their proper lanes on highway curves may be taken. His data are 85.3% in lane, 12.1% crossing less than half, 1.7% crossing more than half, 0.8% crossing fully into the other lane, giving an index of institutionalization of 15.8, which cannot be readily interpreted unless one has many such indices in mind to compare it with. The index of conformity for these data is 93.5%, which has immediate interpretation even to laymen as being 93.5% of maximal or perfect conformity to the traffic regulations.

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[2] The mesokurtic and platykurtic percentages will vary somewhat, depending on the shape of the distribution, the number of class intervals, and the location of the norm between the center and one end. Thus the mesokurtic normal probability curve with $B_2 = 3$ has an index of conformity of 67% when the norm is at the mode. For another example, the platykurtic rectangular distribution of five class intervals illustrated in Fig. 1 has a conformity index of 50% when the norm is at one end and 41% when the norm is the middle class interval. Cfy measures kurtosis strictly only when the norm is the mean.

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Histological Effects of Treatments with Growth-regulating Substances of the 2,4-D Group[1]

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Recent anatomical studies of the bean plant (*2*) and nut grass (*1*) treated with growth-regulating substances of the 2,4-D group (2,4-dichlorophenoxyacetate) have shown that the internal modifications in the monocot are closely similar to those occurring in the dicotyledonous bean plant; and that a monocot, which from superficial study might be reported insensitive or slightly sensitive because of little or no external evidence of effect of the treatment, may be seriously affected in internal structure. Because of difference in method of growth in dicots and monocots the histological modifications naturally vary somewhat in the two plants in type and in position in the plant body, and the external form of the affected organs is modified in different ways. In monocots, external structural effects are commonly less evident than in dicots and may not be at all apparent if the plant dies soon after treatment. Detailed descriptions and photomicrographs of the anatomical modifications of the two plants under treatment are in the papers listed in the references.

In both plants, the modifications occur in immature tissues, as has long been recognized, or in tissues that, though mature, become readily meristematic, especially the pericycle and endodermis. Under both types of growth, primary phloem is distorted or destroyed. In the nut grass, the phloem of the vascular bundles in the growing leaf bases does not form or is destroyed as replacement tissue forms. The xylem is also distorted and its cells filled with gummy substances. The mature vascular bundles in the corm are uninjured. In the bean leaf also, the phloem is distorted or destroyed, and in the young bean stem the primary phloem is destroyed and no secondary phloem forms.

In addition to vascular distortion and reduction, two general types of modification occur: (1) That in which the course of cell and tissue development is so changed that the normal cells and tissues of the region are supplanted by a special type of fleshy parenchyma—with cells proportionately large, more or less irregular in form, strongly vacuolate, without chloroplasts, and with few or no intercellular spaces (Fig. 1B, D). This tissue is suitably called replacement tissue. (2) That in which the response is one of rapid and continuing proliferation of a layer or layers of cells somewhat similar to that of cambial activity (Fig. 2B, D), producing uniform, thin-walled parenchyma cells, some of which become richly cytoplasmic, closely resembling promeristem cells, and give rise to root initials. Proliferation from both vascular and nonvascular tissues is frequent in the young bean plant, with the new tissues arising chiefly from vascular derivatives. In the monocot stem, where there is no cambium, only pericyclic (and to a small extent endodermal) tissue takes part in the formation of new tissue. Proliferation in the stele may extend outward along the leaf traces.

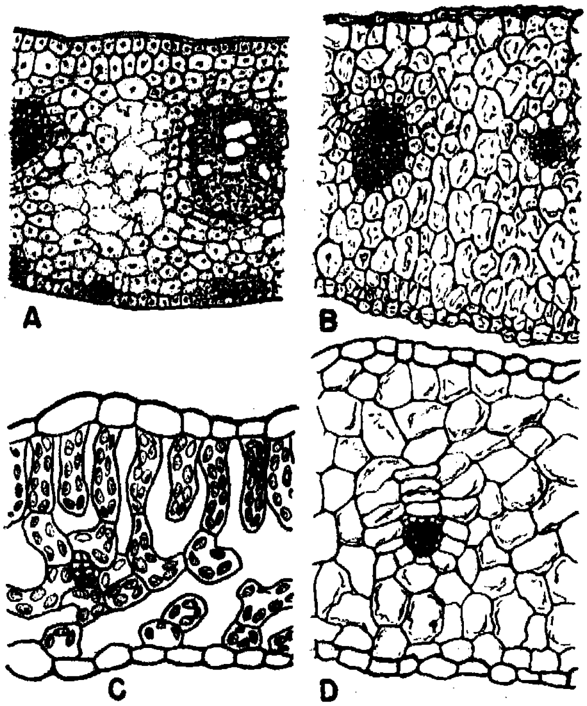

Fig. 1. Transverse sections of portions of normal and treated leaves of nut grass and bean plant. The treated leaves of both plants show increased thickness, replacement tissue, and abortive vascular bundles. A,B, nut grass: A, normal leaf nearing maturity, showing beginnings of differentiation of epidermis, mesophyll, vascular bundles, fiber strands, and aerenchyma; cells with much cytoplasm and conspicuous nuclei. B, treated leaf of about the same stage of maturity as A, lacking normal differentiation of tissues, showing replacement tissue with cells strongly vacuolate and cytoplasm scanty; the vascular bundles reduced and distorted. C, D, bean plant: C, normal mature leaf showing differentiation into epidermis, mesophyll, and small vascular bundle; mesophyll with abundant chloroplasts. D, mature treated leaf showing replacement tissue with cells strongly vacuolate, without chloroplasts; cytoplasm scanty; vascular bundle distorted.

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[1] This paper is based upon work done for the Biological Department, Chemical Corps, Camp Detrick, Frederick, Maryland, under Contract No. W-18-035-CM-168 with Cornell University.

The first type of response (replacement tissue formation) takes place in the leaves and morphologically similar organs; here increase in thickness is minor. In the dicot, conspicuous distortion of external form is soon evident—extreme narrowing of the leaf blade caused by persistence of apical initials and inhibition of development of interveinal tissue (Fig. 3B) with some increase in thickness of blade. In the narrow-leaved monocot, external distortion is inconspicuous because there is little interveinal expansion in normal ontogeny, and with development from a basal intercalary meristem only a basal transverse segment of the leaf is affected (Fig. 3A).

The second type (proliferation tissue formation) occurs in stems (also observed in roots of the bean plant and other dicots and some monocots) and commonly results in extreme swelling of the organ with compression and rupture of the outer tissues, which do not take part in the proliferation. The cortex apparently is little or not at all affected.

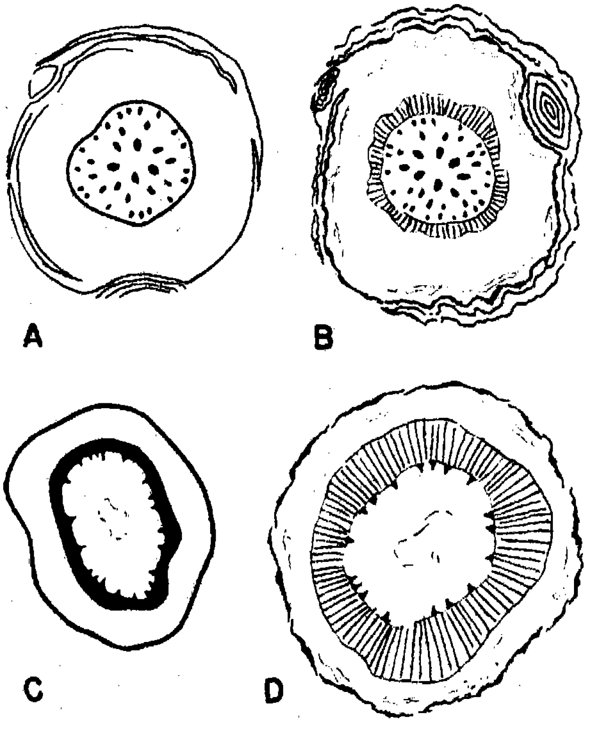

FIG. 2. Cross sectional diagrams of fairly mature corms of nut grass and young stems of the bean plant. A, B, nut grass: A, normal corm showing vascular bundles (black) in the central cylinder surrounded by the pericycle and endodermis (indicated by circle) and cortex with leaf bases and young rhizome tip; B, treated corm showing vascular bundles in the central cylinder as in the normal corm, proliferation of pericycle and endodermis (indicated by the lined area), the cortex somewhat crushed and torn, the epidermis ruptured, and the surrounding leaf bases shrunken. C, D, bean plant: C, normal stem showing vascular cylinder in black with points of protoxylem extending into the pith; D, treated stem showing pith and protoxylem as in the normal stem, proliferating tissue (indicated by the lined area) produced chiefly by the cambium and its derivatives in place of normal secondary vascular tissue, the cortex somewhat crushed and torn, and the epidermis ruptured.

Growth of replacement tissue to maturity is complete in a short time, about the same as in normal development; growth of proliferating tissue may continue for a long time. The same stimulus, however, produces both types of response, and is immediate and brief; there is no later stimulus without further treatment. The stimulus of 2,4-D treatments has been reported to be long-continuing in many plants, but these studies indicate that the reports are based on false interpretation of the evidence. Although the stimulus is immediate and brief, dormancy of some plants after treatment may delay the development of the affected immature tissues or organs (especially buds in woody plants and embryos in seeds) and external evidence of the injury is thus concealed until growth is renewed. Evidence of injury appearing in the spring following treatment is frequent in many plants.

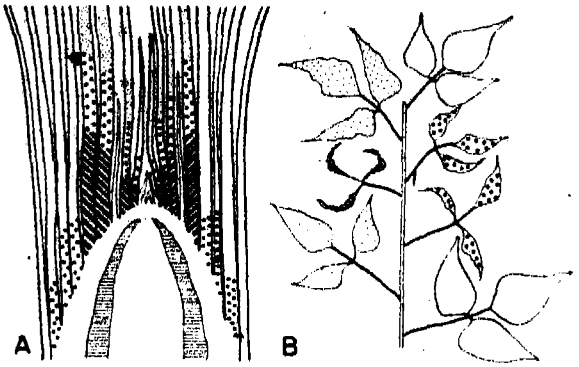

FIG. 3. Extent and distribution of injury in leaves of treated monocot and dicot. Hatching indicates regions of worst injury; large dots, regions of less severe injury; stippling, regions of least injury; and white areas, normal parts. A, diagram of median longitudinal section of tip of corm and base of leaf fascicle of nut grass showing youngest and oldest leaves unaffected and between these the affected ones (immature at time of treatment). The leaf injury is externally inconspicuous because it occurs only in the basal portion of the leaf. In the worst-affected leaves, all three types of injury occur in one leaf. (Horizontally lined area in the corm indicates the proliferated tissue.) B, trifoliolate leaves of bean plant showing youngest and oldest unaffected, and varying degrees of injury in leaves between the unaffected ones. The injury in the bean plant is conspicuous because the whole leaf is distorted and an entire leaf usually shows one type of injury. (A, after Eames, modified; B, after Watson, modified).

From the anatomical study of this monocot and dicot it is clear that, although injury in the bean plant is far more conspicuous externally than in the nut grass (Fig. 3) because of the difference in method of growth, the modifications in both monocot and dicot are fundamentally the same (Fig. 1B, D; Fig. 2B, D).

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Increased Permeability of the Hemoencephalic Barrier Produced by Physostigmine and Acetylcholine[1]

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Nashville, Tennessee

Barbour and Abel (*1*) observed that acid fuchsin, when injected into the lymph sac of frogs, caused tetanic convulsions, but that there was generally a marked delay (often 24 hr) before the onset of the convulsions. These observers believe that the delay was caused by the slow rate of absorption of the dye by nervous tissue. They then removed the cord, treated it with acid, and observed the degree of staining of the cord. The time of onset and the degree of convulsions paralleled the amount of dye in the cord.

TABLE 1

EFFECT OF PHYSOSTIGMINE AND ACETYLCHOLINE ON THE RATE OF ONSET OF CONVULSIONS IN FROGS PRODUCED BY ACID FUCHSIN

	I	II	III
Group	Acid fuchsin	Physostigmine + acetylcholine	Acid fuchsin + physostigmine + acetylcholine
Number of frogs	19	23	26
Number that did not have convulsions ...	5	23*	4
Number that had convulsions in less than 1 hr	4	0	22
Number that had convulsions in a period longer than 1 hr ...	10	0	0
Average time for convulsions to occur ...	12.6 hr		34 min
Range of times for convulsions to occur ...	41 min–26 hr		18 min–49 min

* Four frogs in this group died without evidence of convulsions.

In our work on factors affecting the permeability of dog erythrocytes it was found that a disturbance of the acetylcholine-cholinesterase system affected the permeability (*2*), and it was felt that a simple method of determining whether other cells were also affected might be found by studying the effect of physostigmine, a specific inhibitor of cholinesterase, and acetylcholine on the rate of passage of dye through the hemoencephalic barrier as indicated by the degree of staining of the cords of frogs treated with physostigmine, acetylcholine, and acid fuchsin and the time of onset of convulsions.

The drugs were injected into the dorsal lymph sacs of the frogs in the following quantities: acid fuchsin 5 mg, acetylcholine bromide 1 mg, and physostigmine 0.1 mg for each 5 g of body weight. The time when convulsions occurred was then determined.

Experimental results are summarized in Table 1. It may be seen that of the 19 frogs receiving acid fuchsin alone, 14 went into convulsions and the average time for the onset of convulsions in these frogs was 12.6 hr. Of the 26 frogs receiving acid fuchsin, physostigmine, and acetylcholine, 22 went into convulsions, and the average time for the onset of convulsions in this group was 34 min. In this group if the frogs did not convulse in an hour they did not convulse at all. Of the 23 frogs receiving physostigmine and acetylcholine, four died without showing signs of convulsions. Tests for acid fuchsin in nervous tissue by Abel's method were positive when the frogs were in convulsions caused by physostigmine and the dye, and negative if convulsions had not begun. We also observed, as did Abel, that the frog's eye became deeply pigmented at the time of onset of convulsions.

On applying the chi-square test of significance to these results it was found that the probability that this was a chance distribution was less than 0.001.

The permeability of the hemoencephalic barrier of frogs to acid fuchsin appears to be increased by the inhibition of cholinesterase by physostigmine. This change in permeability is similar to that found in dog erythrocytes treated with physostigmine. The acetylcholine-cholinesterase system may have a widespread function in maintaining the normal permeability of the living cell.

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[1] Funds for carrying on this work were kindly supplied by the Mallinckrodt Chemical Works.

[2] U. S. Public Health Fellow of the National Institutes of Health.

Dispersion Staining with Phase Contrast Microscope Accessories. The Microscopic Identification of Quartz

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Results similar to the transmitted light bright field Christiansen effect (*1*) and the dark field dispersion staining method (*2–6*) can be obtained with chemicals and minerals by means of phase contrast microscope accessories. The colors obtained with phase objectives as compared to non-phase are much more vivid—brilliant enough to produce good color transparencies. A further advantage is that they can be observed best at focus rather than above or below a good focus, a necessary condition with non-phase objectives. As compared to the dark field method, the colors are not quite as brilliant and are observed best at the lower magnifications, such as with the 10 × (16-mm) 0.25 N.A. and 21 × (8-mm) 0.50 N.A. objectives. Weak coloration can very often be obtained with the 43 × (4-mm) 0.65 N.A. objective. This is especially true when using the higher index liquids which, containing a greater proportion of cinnamaldehyde, have a higher dispersion. The use of high dispersion liquids as mounting media with the phase microscope offers the advantage that the end point in the determination of refractive index by color is probably easier to obtain than by dark field illumination. Critical numerical aperture relationships between condensers and objectives necessary in the dark field method are not required. When the method is used in conjunction with polarized light, more than one identifying color can be obtained, dependent on the orientation of the specimen. Particles not readily visible at one optical orientation can often be reorientated so they stand out in sharp contrast to the mounting medium. The method can be illustrated best by the directions given below for the identification of quartz, N_ω 1.544 and N_ϵ 1.553.

Particles, crushed to a smaller size if necessary, should be mounted under a cover glass in a liquid of high dispersion and of a refractive index of n_D 1.544 at 25° C prepared from a mixture of diethylene glycol monobutyl ether and cinnamaldehyde (Eastman Kodak Company). The quantity of the lower index constituent, to be mixed with the higher to give an index of 1.544 at 25° C, can be determined by the formula

$$V_1 n_1 + V_2 n_2 = V_x n_x$$

where V represents volume, n the index, and $V_x n_x$ the volume and index desired. Our samples of diethylene glycol monobutyl ether had an index of 1.429 and cinnamaldehyde 1.619, both readings being taken at 25° C. A 1.544 index liquid would require a mixture of 3.95 cc of diethylene glycol monobutyl ether with 6.05 of cinnamaldehyde, as shown in the computation given below:

$$\begin{aligned} 1.429V_1 + 1.619V_2 &= 10\ (1.544) \\ 1.429V_1 + 1.429V_2 &= 10\ (1.429) \\ .190V_2 &= 1.15 \\ V_2 &= 6.05 \text{ cc} \\ V_1 &= 3.95 \text{ cc.} \end{aligned}$$

For more accurate results, the mixture prepared according to the above formula should be checked on a refractometer at 25° C. It is also advisable to recheck its index occasionally for any change, since cinnamaldehyde tends to oxidize to cinnamic acid. This shift in index can be retarded by keeping the index liquid in a small bottle and maintaining it nearly full of the mixture. Other index liquid combinations can be used, but the colors obtained will tend to be less vivid.

The results given here were obtained with dark contrast phase objectives having phase accelerating annuli of one-quarter wavelength. Critical illumination should be employed and the condenser diaphragm image and phase accelerating annulus accurately centered. A microscope illuminator having a 6-v 108-w ribbon filament lamp and daylight filter was used as a light source. Preparations mounted in the 1.544 index liquid were examined at a temperature of 25° C by means of the 10 × (16-mm) 0.25 N.A. and 21 × (8-mm) 0.50 N.A. objectives. Observations were made with nonpolarized light and with polarized light obtained by placing a cap analyzer over the microscope eyepiece. Grains of quartz with nonpolarized light at 25° C appear colored blue with orange. With polarized light (cap analyzer over eyepiece) grains oriented for the 1.544 index are colored blue with red, and those oriented for the 1.553 index are blue with yellow. Any inclusions or particles on the surface appear white or in colors other than those characteristic for quartz. As an additional means of identification, grains can be examined in a 1.553 (epsilon index for quartz) index liquid prepared in a similar manner at 25° C from diethylene glycol monobutyl ether and cinnamaldehyde. Quartz grains in this liquid with nonpolarized light at 25° C appear light blue, usually with a very dark red border. With polarized light (cap analyzer over the eyepiece) grains oriented for the 1.553 index are colored blue with red and those for the 1.544 index a light blue to white. The red, orange, and yellow colors are usually in the form of colored borders to the grain but occasionally, depending on its shape, can be found at any point in the particle. The blue colors always cover the major portion of the grain and vary in hue from light to dark blue, depending on whether the grain is below, equal to, or above the index liquid. This criterion in conjunction with the red, orange, and yellow coloration is of additional value in determining the grain-index relationship.

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Book Reviews

Introduction to historical geology. Raymond Cecil Moore. New York-London: McGraw-Hill, 1949. Pp. ix + 582. (Illustrated.) $5.00.

This new book bids fair to become one of the leading textbooks in the country for beginning college courses. It is an authoritative treatment of historical geology by a leading student of stratigraphy and paleontology, and a teacher of more than thirty years' experience.

The facts of historical geology are presented concisely and clearly, by means of lucid text, large and beautiful illustrations, diagrams, correlation tables, areal and paleogeographic maps on facing pages, and many figures of fossils and restorations of landscapes and both vertebrate and invertebrate animals.

The book is well suited to beginning classes in geology, and the correlation tables and areal and paleogeographic maps make it useful for more advanced students of the stratigraphy of North America. Students use their texts in historical geology in identifying the fossils they collect on geological excursions. It would be better, the reviewer thinks, if the names of species had been given so that the figures could be used for specific as well as for generic identification.

Dr. Moore's book is fully equal, in the reviewer's estimation, to any textbook in historical geology now being used in this country. It is logically written, adequately illustrated, and is authoritative, accurate and up to date.

J. J. GALLOWAY

Indiana University

Elastomers and plastomers: their chemistry, physics and technology. (Vol. III.) ***Testing and analysis; tabulation of properties.*** R. Houwink. (Ed.) New York: Elsevier Publ., 1948. Pp. 174. (Illustrated.) $4.50.

This third volume of the series edited by Hermans, Houwink, and Martin is essentially devoted to methods of analysis and testing and to a presentation of numerical data on the mechanical, electrical, optical, and thermal properties of high polymers. This is a very important subject and a book on it is a welcome addition to the scientific literature in this field.

J. H. Teeple describes in about sixty pages the modern methods of plastics and rubber testing in a comprehensive, clear, and up-to-date manner, using a large number of well-selected figures and tables. A. G. Epprecht follows with a chapter on chemical analysis, which will be particularly interesting for American readers because it contains many European methods which are not as yet too well known in this country. A chapter by B. B. S. T. Boonstra on properties of elastomers gives additional information on these important materials, and the fifth chapter of J. W. F. Van 't Wout and R. Houwink completes the volume by discussing the properties of plastics.

It is evident that books of this character are very valuable and necessary for chemists and physicists interested in this rapidly expanding field, and Dr. Houwink's series is contributing a great deal to the dissemination of factual knowledge and current ideas.

H. MARK

Polytechnic Institute of Brooklyn

Foundations of nuclear physics: facsimiles of thirteen original studies. Robert T. Beyer. (Ed.) New York 19, N. Y.: Dover Publ., 1949. Pp. 272. (Illustrated.) $2.95.

The use of original papers as a teaching device has been recognized in the natural sciences ever since Wilhelm Ostwald first reprinted a series of classics in the natural sciences. However, most of these papers were concerned with developments in days gone by, and only a few volumes in this series (in German) are devoted to modern developments (such as the volume on Brownian motion, which contains the famous papers by Einstein and Smoluchowski). The present volume presents a particularly interesting collection of thirteen of the fundamental studies in nuclear physics as they were originally reported in scientific journals. Everybody will agree with Professor Beyer as to the importance of the various papers. All of them had a profound influence on the development of nuclear physics and they cover a wide range of interests, from simple experimental descriptions to some rather difficult theoretical developments such as, for instance, Fermi's theory of β-decay and the theory of the interaction of elementary particles by Yukawa.

Of the classical papers on radioactivity, Rutherford's papers on the scattering of alpha particles and on artificial nuclear disintegration are included. The other papers are of the period when modern techniques made the discovery of new particles possible and wave mechanics gave the interpretation of their interaction with matter.

One may regret that Fermi's detailed paper from the *Proceedings of the Royal Society* has not been reprinted; also that the paper of the Joliots in the *Journal de Physique* has not been given instead of the short note in *Comptes Rendus*. We hope that a future edition will contain the brief note by Frisch and Meitner on fission. For the sake of the student one might wish that papers were accompanied by a commentary, because the beginner will find it necessary to have proper guidance if he wants to study this material by himself.

The bibliography, which covers such chapters as isotopes and mass measurements, hyperfine structures, nuclear moments and spin, scattering and collision processes, disintegration processes, radioactivity, beta radiation, gamma radiation and neutrons, the theory of nuclear structure, theory of disintegration processes, nuclear fission, and finally a chapter on methods and apparatus, will be useful to the beginner as well as the research worker and teacher who wants a handy classified list of sources.

KARL LARK-HOROVITZ

Purdue University

Advances in catalysis and related subjects. W. G. Frankenburg, V. I. Komarewsky, and E. K. Rideal. (Eds.) New York: Academic Press, 1948. Pp. viii + 321. (Illustrated.) $7.80.

This book is a collection of the following eight articles: "The Heterogeneity of Catalyst Surfaces for Chemisorption," by Hugh S. Taylor; "Alkylation of Isoparaffins," by V. N. Ipatieff and Louis Schmerling; "Surface Area Measurements. A New Tool for Studying Contact Catalysts," by P. H. Emmett; "The Geometrical Factor in Catalysis," by R. H. Griffith; "The Fischer-Tropsch and Related Processes for Synthesis of Hydrocarbons by Hydrogenation of Carbon Monoxide," by H. H. Storch; "The Catalytic Activation of Hydrogen," by D. D. Eley; "Isomerization of Alkanes," by Herman Pines; and "The Application of X-Ray Diffraction to the Study of Solid Catalysts," by M. H. Jellinek and I. Fankuchen.

All of the articles will be read with much interest. However, the time has not yet arrived when one specifies exact mechanisms for most catalyst reactions. Taylor presents interesting data which indicate hydrogen is chemisorbed on nickel-chromia catalysts, for example, in two different ways—one at a temperature below − 78° C and the other above 0° C. He succeeds in adducing much evidence to show the nonuniformity of chemisorption on various surfaces. The other authors likewise provide much new information. Every chapter is written by a specialist in the particular field and the contents are accurately indicated by the titles. A person concerned with catalysis should certainly consult this book.

HENRY EYRING

University of Utah

Detailed atlas of the head and neck. Raymond C. Truex and Carl E. Kellner. New York: Oxford Univ. Press, 1948. Pp. xiii + 162. $15.00.

We find in this atlas an unusually complete coverage of the anatomy of the head and neck. Some eighty of the figures are of dissections and thirty of frontal or transverse sections. In all but a few plates of the skull and vertebrae, the artist has been painstaking and successful in representing by line and shade the finer structure of organs and the texture of tissues. Blood vessels and nerves are in colors. The figures are large, some of them over life size.

An atlas, a chart, or a model may lose much of its value by faulty labeling. This feature has been given careful consideration. Labels are abundant and this abundance is reflected in the extent of the index. The special problem of labeling the closely packed structures of some sections of the head is met by repeating the central part of the plate on the opposite page.

In any atlas that faithfully records anatomical preparations there are inevitable variations from the more usual anatomy. These misleading features are usually passed over in silence. Here they are commented on in the explanatory paragraphs accompanying the plates.

The volume will serve as a highly valuable addition to the working equipment of certain clinical specialists and anatomists. Its contents are too extensive for daily use by the first-year student but it should be made available to him for reference.

JOHN J. SHEININ

Chicago Medical School

Scientific Book Register

BENEDICT, MANSON, and WILLIAMS, CLARKE. (Eds.) *Engineering developments in the gaseous diffusion process.* New York: McGraw-Hill, 1949. Pp. xx + 129. (Illustrated.) $1.25.

BENT, ARTHUR CLEVELAND. *Life histories of North American thrushes, kinglets, and their allies.* (U. S. National Museum Bull. 196.) Washington, D. C.: Supt. of Documents, U. S. Govt. Prntng. Office, 1949. Pp. viii + 454. (Illustrated.) $1.50.

BURSTEIN, CHARLES L. *Fundamental considerations in anesthesia.* New York: Macmillan, 1949. Pp. x + 158. (Illustrated.) $4.00.

DAVIES, OWEN L. (Ed.) *Statistical methods in research and production: with special reference to the chemical industry.* (2nd ed., rev.) New York (3): Stechert-Hafner; London and Edinburgh: Oliver & Boyd, 1949. Pp. xi + 292. 28/–.

EDGELL, GEORGE HAROLD. *The bee hunter.* Cambridge, Mass.: Harvard Univ. Press, 1949. Pp. 49. (Illustrated.) $2.50.

EDMONDSON, CHARLES HOWARD. *Seashore treasures.* Palo Alto, Calif.: Pacific Books, 1949. (Illustrated.) Pp. 144. $3.50.

GRASSE, PIERRE-P. (Ed.) *Traité de Zoologie: Anatomie, Systématique, Biologie: Onychophores, Tardigrades, Arthropodes, Trilobitomorphes, Chélicérates.* (Tome VI). Paris (VIe): Masson et Cie, 1949. Pp. 979. (Illustrated.) 5000 fr.

WENTZEL, GREGOR. *Quantum theory of fields.* (Translated from the German by Charlotte Houtermans and J. M. Jauch.) New York, London: Interscience, 1949. Pp. ix + 224. $6.00.

WISLER, C. O. and BRATER, E. F. *Hydrology.* New York: John Wiley, 1949. Pp. xi + 419. (Illustrated.) $6.00.

NEWS and Notes

Wendell Latimer has resigned as dean of the College of Chemistry at the University of California to devote his full time to nuclear research. Dr. Latimer will be succeeded by **Joel Hildebrand**, who has been both chairman of the Department of Chemistry and dean of the College of Letters and Science.

Alex J. Steigman is now serving as consultant in clinical epidemiology for the National Foundation for Infantile Paralysis, in New York City, where he will conduct field work in early diagnosis, management, and epidemiologic investigations of poliomyelitis. During a recent two-year period as senior fellow in pediatrics with the National Research Council, Dr. Steigman conducted investigations in poliomyelitis at the Children's Hospital Research Foundation, in Cincinnati, Ohio.

Bernard B. Watson, associate professor of physics at Temple University, has been appointed specialist for physics in the Office of Education of the Federal Security Agency.

Paul R. Trumpler, engineer at the centrifugal engineering department of the Clark Brothers Company of Olean, New York, has been appointed professor of mechanical engineering at Illinois Institute of Technology.

John F. Fulton, Sterling Professor of Physiology, has been appointed Rosenbach Fellow in Bibliography for 1949–50 at the University of Pennsylvania. Dr. Fulton will deliver three lectures on "The Great Medical Bibliographers" on February 2, 9, and 16, 1950.

Ward Pigman, head of the organic chemistry group at the Institute of Paper Chemistry, Appleton, Wisconsin, has been appointed associate professor of biochemistry at the Medical College and Dental School of the University of Alabama, Birmingham.

William A. Ritchie, curator of anthropology at the Rochester Museum of Arts and Sciences, has been appointed senior scientist in archaeology at the New York State Science Service and the New York State Museum. Dr. Ritchie is the author of *The pre-Iroquoian occupations of New York State*, which was awarded the A. Cressy Morrison Prize in Natural Science in 1943 by the New York Academy of Science.

James F. Bonner, professor of biology at California Institute of Technology, **Karl Hamner**, University of California plant physiologist, and **William Albrecht**, professor of soil science at the University of Missouri, are attending the Commonwealth Agricultural Specialists Conference in Australia.

F. Gray Butcher, entomologist with the North Dakota Agricultural College, has accepted an appointment as assistant professor of zoology at the University of Miami, Coral Gables. Dr. Butcher will teach courses in economic entomology and conduct research on horticultural pests of the area.

Richard Crutchfield, chairman of the Department of Psychology at Swarthmore College, will spend the academic year as visiting professor at the University of California at Berkeley. **William C. H. Prentice** has been made associate professor and acting chairman of the Swarthmore department.

Visitors to U. S.

D. Hans F. Häusler, of the Department of Pharmacology, University of Graf, Austria, returned home on August 16 after spending three months at medical centers in this country and Canada. Dr. Hausler's visit was sponsored by the Rockefeller Foundation.

Pedro Regules, ear, nose, and throat specialist from Montevideo, is spending a month here. Dr. Regules will visit the army hospitals at Philadelphia and New York.

Recent visitors at the National Bureau of Standards included **K. H. Chen**, instructor at the National Institute of Health, Central Hospital, Nanking, China; **P. M. Millman**, astronomer, Dominion Observatory, Department of Mines and Resources, Ottawa, Canada; **Henrik Nordenfelt**, engineer from Stockholm, Sweden; **Henry G. Sutton**, director, Sutton Tool and Gauge Manufacturing Company, Ltd., Victoria, Australia; **Gilbert Raes**, head of the Textile Laboratory, University of Ghent, Belgium; **J. Shone**, physician with the Ministry of Health, Andrews Memorial Hospital, Kingston, Jamaica; and **Jack Hampton Willis**, advisor on manufacturers' problems, with the Australian Wool Realization Commission, Australia.

George Addison, plant geneticist in the Instituto Agronomico do Norte, Belem, Para, Brazil, is visiting here for six weeks to consult with American geneticists. Mr. Addison will spend a week conferring with officers of the Department of Agriculture in Washington and will then tour northern and eastern states.

Grants and Awards

The American Institute of Nutrition announces that nominations are now being solicited for the 1950 **Mead Johnson and Company B-Complex Award**, the **Borden Award in Nutrition**, and the **Osborne and Mendel Award**, to be presented at the annual meeting of the institute next spring. These three $1,000 awards are made annually.

The Mead Johnson Award is given to the laboratory or clinical research worker in the U. S. or Canada responsible for the publication during the previous calendar year of the best scientific report dealing with the field of the B-complex vitamins. The Borden Award is given to U. S. or Canadian investigators in recognition of distinctive research emphasizing the nutritive significance of milk or dairy product components. It is made primarily for the publication of specific papers but may be given for important contributions over an extended period of time and may be divided between two or more investigators. The Osborne and Mendel Award is given to the investigator who has made the most significant published contribution in the year preceding the annual meeting or who has published a series of contemporary papers of outstanding merit. All nominations must be in the hands of the Nominating Committee by *January 15, 1950.* The nominations, which can be made by anyone, should be accompanied by data relative to the research of the nominee. Membership in the institute is not a requirement for eligibility.

The National Research Council of Ottawa, Canada, has awarded two **Merck post-doctoral fellowships** in the natural sciences for 1949–50. The grants have been made to D. A. I. Goring, of the Department of Physical Chemistry at McGill University, who will study colloid science at Cambridge University, England; and M. J. Miller, of the Institute of Parasitology at Macdonald College, Canada, who will continue his research in medical parasitology and clinical tropical medicine at the School of Tropical Medicine, University of Calcutta, India.

Smith, Kline and French Laboratories, Philadelphia, has awarded traveling fellowships of $5,000 each to Edward B. Ferguson, Jr., of Tulane University, and Charles J. Kensler, of Cornell University. Dr. Ferguson will study the physiology of the kidney at Cambridge University, and Dr. Kensler will conduct pharmacological research at Oxford University.

Colleges and Universities

The University of Notre Dame's radiation chemistry project, formerly supported in part by the Office of Naval Research, will from now on be operated under the auspices of the Atomic Energy Commission. The project is devoted entirely to solution of fundamental problems in radiation chemistry and will handle none of the technological features involved. Fields now under investigation include the effects of high energy radiation on ionic solids and on organic compounds and solutions, the mechanism of chemical processes involving nuclear recoil, and radiation chemical monitoring. Studies on aqueous systems and protophotosynthesis are planned. Training of workers is an important part of the program. Faculty members who will direct work in the project include Milton Burton, Andrew J. Boyle, William H. Hamill, John L. Magee, and Russell R. Williams, Jr.

The University of Maryland and the **Naval Ordnance Laboratory** will establish an Institute of Fluid Dynamics and Applied Mathematics at the university this fall. Directors of the institute will be Kampe de Ferriet, of the University of Lille, now a consultant to NOL, and Alexander Weinstein, member of the NOL Mechanics Division.

Meetings and Elections

From June 22 to June 28, 1949, the University of Denver was host to a group of physicists who gathered in Idaho Springs, Colorado, near the Inter-University High Altitude Laboratory at Echo Lake, for a **Symposium on Cosmic Rays.** The meeting was remarkable for the attendance, for the number and importance of the papers presented, and, not least, for the excellent organization, due mainly to Profs. Cohn and Iona of the University of Denver.

The discussions centered on four major subjects, namely (1) properties of mesons (discussion leaders: Anderson and Brode); (2) nuclear interactions of cosmic rays (discussion leader: Rossi); (3) primary radiation (discussion leaders: Wheeler and Schein); and (4) air showers (discussion leaders: Bethe and Greisen). Reports on previous investigations concerning these various subjects had been prepared by the discussion leaders and distributed to the participants, so that the work of the conference could be focused on the most recent developments.

During the discussion on the properties of mesons, Barkas reviewed the results obtained at Berkeley on mesons produced artificially by means of the cyclotron and the synchrotron. He presented tentative data on cross sections for meson production by α-particles, protons, neutrons, and γ-rays of different energies, as well as the latest values for the masses of the π- and the μ-meson (215 and 285 electron masses respectively) and for the mean life of the μ-meson (0.68×10^{-8} sec). Among the results concerning "natural" μ-mesons, one may mention a new mass determination by Anderson, based upon the measurement of the maximum energy of their decay electrons, which gave a value of 217 electron masses.

Much of the discussion on nuclear interactions of cosmic rays centered on such questions as the cross sections of various elements for these interactions and the nature of the secondary products. Many of the physicists attending the meeting described new experimental results, obtained at mountain altitudes or with balloon and rocket experiments and bearing more or less directly on these questions. During the discussion, a number of interesting and spectacular pictures were presented, obtained both with the cloud chamber method and by means of the newly developed photographic emulsions that are sensitive to particles with minimum ionization. Some remarkable pictures by Peters and Bradt were presented, showing the disruption of heavy primary cosmic ray particles in their collisions with nuclei of elements contained in photographic emulsions and some cloud chamber pictures of Tinlot and Gregory, showing the production of high energy photons in the interactions of cosmic ray neutrons with nuclei of lead and aluminum.

The first part of the discussion on the primary radiation concerned geomagnetic effects, with special emphasis on the latitude variation of the nucleonic component of cosmic rays and of the heavy primary particles. The second part of the discussion dealt mostly with experimental results on the nature of primary cosmic rays obtained by means of rocket and balloon experiments. From these results it appears that between 80 and 90 percent of the primary rays are protons, the rest being heavier nuclei, mainly helium nuclei (Peters, Nye). No appreciable number of electrons or photons seem to be present in the primary radiation Hulsizer, Nye).

During the discussion on air showers, Cocconi and others described recent experimental results concerning the relative abundance and the spatial distribution of the various kinds of particles (electrons, mesons, nucleons) that form these showers. Blatt presented some new developments in the theory of the lateral distribution of the electronic component. Bethe suggested a tentative theoretical picture for the development of an air shower, describing it as a chain of nuclear interactions initiated by the arrival upon the atmosphere of an extremely energetic proton. Each nuclear interaction gives rise to several secondary nucleons, π-mesons, and neutral mesons. The neutral mesons immediately decay into photons, which then undergo cascade multiplication.

BRUNO ROSSI

The Society for Applied Spectroscopy will meet October 4 at 8 p.m. at the Socony-Vacuum Training Center, 63 Park Row, New York City. Ralph H. Muller, of New York University, will speak on "Instrumental Methods of Analysis."

The 34th Annual Meeting of the Optical Society of America will be held at the Hotel Statler, Buffalo, New York, on October 27–29, 1949. The program includes a symposium on microscopy and invited papers on the following subjects: "Electron Microscopy," by L. Marton, National Bureau of Standards; "Infrared and Raman Spectra of Crystals," by Donald F. Horning, Brown University; "Analysis of Segregates in Alloys," by J. Convey, Canadian Bureau of Mines; "Spectrochemical Research in the Union of South Africa," by A. Strasheim, National Physical Laboratory, Pretoria, South Africa; "The Eye and the Camera," by George Wald, Harvard University; and "High Precision Measurements with Simple Equipment," by A. C. S. van Heel, Technical University, Delft, Holland.

A conference on mechanisms and evaluation of antiseptic activity will be held in New York City October 28–29 under the auspices of the Biology Section of the New York Academy of Sciences. The Friday afternoon sessions will be devoted to the antibiotics, Friday evening to quaternary ammonium compounds and other chemicals characterized by high surface activity, and Saturday morning to the halogens, mercurials, alcohols, and other agents, as well as high temperature. Attendance will be limited to members of the academy and invited guests. Scientists interested in participating may obtain further information from Mrs. Eunice Thomas Miner, Executive Director, New York Academy of Sciences, Central Park West at 79th Street, New York 24, New York.

The Second Annual Nucleonics Symposium, sponsored by the Institute of Radio Engineers and the American Institute of Electrical Engineers, will be held at the Hotel Commodore in New York City on October 31–November 2. The program will include a round-table discussion on "Evaluation of Radiation Hazards," and an address by Karl T. Compton, chairman of the Research and Development Board of the National Military Establishment.

The Fluid Dynamics Division of the American Physical Society will hold a symposium at the University of Virginia December 28–30 on "Irreversible Processes in Fluid Dynamics." Five half-day sessions will be devoted to energy transport and exchange, viscous and plastic flows, mass transport and fluctuation, entropy changes in irreversible processes, and energy transfers in shock, flame, and detonation fronts. In addition there will be one half-day session for contributed papers. Requests for accommodations by nonmembers should be sent to the Secretary, School of Physics, Rouss Physical Laboratory, University of Virginia, Charlottesville, Virginia, as soon as possible.

The Chemistry Section of the AAAS will hold its annual meeting in New York City on Friday and Saturday, December 30 and 31, in the Statler Hotel. Two symposia are being planned, one by George Glocker, of the State University of Iowa, on "Progress in Chemistry," and another by Robert S. Shelton, of the William S. Merrel Company, on "Some Recent Advances in Medicinal Chemistry." Papers for a general session are solicited. Titles and abstracts should be sent to Dr. E. F. Degering, Department of Chemistry and Chemical Engineering, Armour Research Foundation, Technology Center, Chicago 16, on or before *October 1.*

The American Society of Mammalogists, at its 29th annual meeting in Washington, D. C., elected the following officers: president, Tracy I. Storer, University of California; vice-presidents, Lee R. Dice, University of Michigan, and William J. Hamilton, Jr., Cornell University; corresponding secretary, Donald F. Hoffmeister, University of Illinois; recording secretary, Robert T. Orr, California Academy of Science; treasurer, Viola S. Schantz, U. S. Fish and Wildlife Service; and editor, William H. Burt, University of Michigan.

At a recent meeting of the Board of Trustees of the **Worcester Foundation for Experimental Biology**, Charles B. Huggins, professor of surgery at the University of Chicago, George W. Calver, of the U. S. Navy, and Ralph F. Gow, executive vice-president of the Norton Company were elected trustees for a term of four years.

The American Society for Metals has elected the following officers for the coming year: president, Arthur E. Focke, research metallurgist for the Diamond Chain Company, Indianapolis, Indiana; vice president, Walter E. Jominy, staff engineer at the Chrysler Corporation.

Deaths

George Hugh Henderson, 56, O. E. Smith Professor of Physics, Dalhousie University, Halifax, Nova Scotia, died on June 19 en route to New Brunswick on a fishing trip. Professor Henderson was well known for his researches in radioactivity and in the study of pleochroic halos. He was a fellow of the Royal Society of London and of the Royal Society of Canada.

Carlos G. Bates, 64, a fellow of the Society of American Foresters and veteran of 42 years of research work in the U. S. Forest Service, died of a heart attack at his home in St. Paul on July 22. Since 1928 Dr. Bates had been attached to the Lake States Forest Experiment Station in St. Paul.

Donche Kostov, 52, biologist, died at his home in Sofia, Bulgaria on August 10 after a long illness. He had been working on a Bulgarian translation of the works of Michurin, the Soviet biologist, at the request of the Bulgarian government.

John Frederick Speck, 29, research associate in the Department of Biochemistry at the University of Chicago, died August 18 in an accident while mountain climbing in the French-Italian Alps. Dr. Speck was on leave of absence from the University of Chicago and had been a Rockefeller Fellow in the Nobel Institute at Stockholm, Sweden, since last fall.

Frank Thone, 58, biology editor of Science Service, died August 25 of a heart attack in Washington, D. C. A specialist in plant ecology, Dr. Thone joined the staff of Science Service in 1924. In 1946 he received a Westinghouse award for distinguished science writing. He was the author of *Trees and flowers of Yellowstone National Park* and *The microscopic world.*

A new periodical, ***Angiology, The Journal of Peripheral Vascular Diseases,*** will begin publication in February 1950. Saul S. Samuels, chief of the Department of Peripheral Arterial Diseases, Stuyvesant Polyclinic Hospital, New York City, will be editor-in-chief. Among associate editors in the U. S. are Alton Ochsner, of Tulane University; Keith Grimson, of Duke University; Leo Loewe, of Long Island Medical College; D. W. Kramer, of Jefferson Medical College; and Gerald Pratt, of New York University Medical School. The journal will be published by the Williams and Wilkins Company and sold at a subscription price of $8.00 a year.

The Japanese Journal of Experimental Medicine, which, until it ceased publication in October 1941, was the most important English language journal of Japanese medicine, resumed publication with Volume 20, No. 1, March 1, 1949. The Army Medical Library has a few extra copies of this volume for distribution upon request to interested libraries that did not receive it.

Recently Received—

Research Today: New Research in Antibiotics. (Spring issue.) Issued by Lilly Research Laboratories, Eli Lilly and Company, Indianapolis 6, Ind.

Critical Requirements for Research Personnel: A Study of Observed Behaviors of Personnel in Research Laboratories. American Institute for Research, Pittsburgh, Pa.

Fishery Statistics of the United States 1945. (Statistical Digest No. 18, Fish and Wildlife Service, published in 1949.) For sale by Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C. at $1.50.

Symposium on Thermodynamics. (Sponsored by the International Union of Pure and Applied Physics. Held in Brussels, January 1948.) In French and English. Printed by J. & R. Sennac, Paris IX^e^, France.

Studies in Experimental Zoology: Regeneration, Experimental Embryology, Endocrinology by A. Elizabeth Adams. (3rd. ed.) Order from Edwards Brothers, Inc., Ann Arbor, Mich.

Anais da Associação Quimica do Brasil. Publicados trimestralmente by Associacao Quimica do Brasil, Caixa, 1815, S. Paulo, Brazil.

Institute of Metals (reprints from March 1949 *Journal*): Constitution of Aluminum-Copper-Magnesium Alloys; Crystallite Theory of Strength of Metals; Relation between the Degree of Order and the Lattice Parameter of Cu_3Au; and Pure Platinum, of High Recrystallization Temperature, Produced by Power Metallurgy. Institute of Metals, London (S.W.1), England.

Tables of Scattering Functions for Spherical Particles (National Bureau of Standards Applied Mathematics Series #4). Obtainable from Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C. 45¢ a copy.

Diet in Relation to Reproduction and the Viability of the Young (Part I): Rats and Other Laboratory Animals, by F. C. Russell. (Commonwealth Bureau of Animal Nutrition, tech. comm. 16.) Order from Central Sales Branch, Commonwealth Agricultural Bureaux, Penglais, Aberystwyth, Gt. Britain. Price 6/– sterling.

List of Scientific Papers published in the Middle East, compiled by Unesco's Science Cooperation Office, Cairo, Egypt.

Bibliography on Sprays by Kalman J. DeJuhasz. Published by The Texas Company, Refining Dept., Technical and Research Div., 135 E. 42nd Street, N. Y.

Make Plans for—

The Board of Governors of the National Speleological Society will meet October 1 at the American Museum of Natural History, New York City.

Electron Microscope Society of America, annual meeting, October 6–8, National Bureau of Standards, Washington, D. C.

Society of American Foresters, national meeting, October 11–13, Olympic Hotel, Seattle, Washington.

American Standards Society, 31st annual meeting, October 11–14, Waldorf-Astoria Hotel, New York City.

Electrochemical Society, 96th annual convention, October 12–15, La Salle Hotel, Chicago, Illinois.

Correction: It was erroneously stated in the August 26 issue of *Science* (p. 220) that the December 29 AAAS symposium on *Botany in the Service of Mankind* would be held at the Hotel Statler. The session will be held in the Winter Garden of the Hotel McAlpin.

The Concept of Action as a Measure of Living Phenomena

Martin Ruderfer

Brooklyn, New York

THE HISTORY OF SCIENCE is the history of measurement. The enormous strides made in the last three centuries in astronomy, physics, and chemistry can be directly traced to the ability to measure and compare forms of inert matter with precision and consistency. The balance, the scale, the clock, and their countless derivatives were the major source of facts upon which the inert sciences were nurtured.

Today increasing emphasis is being placed upon the study of living phenomena. But here an imposing barrier to progress exists: The measuring techniques which are the foundation of the inert sciences are not convenient for the measurement of living phenomena. The mass and dimensions of a rock, for instance, may remain remarkably constant from day to day, and year to year, whereas the mass and dimensions of a living thing, because of the growth and death process, food consumption, and other factors, are inherently variable with time. Furthermore, these properties cannot be as precisely defined for living things as for inert things. For example: What are the characteristic dimensions of an amoeba? In interspecies comparisons of mass, how are hair, bones, horns, hoofs, nails, etc. to be considered? Is the height of an animal the distance from top of shoulder—or head—above ground, or the distance from end of tail to tip of nose—or horn? Thus, uncertainty and variability in the mass and dimensions of living things vitiate the accuracy of their measurement, no matter how precisely obtained, and serve to preclude the application of the mass-length-time system to living phenomena. If this barrier were removed, i.e., if a universal measuring rod were made available for the biological sciences that could form the basis of a system of measurement similar to the mass-length-time system in the physical sciences, then immeasurable benefits could be expected.

There are two universal properties of living things upon which such a measuring rod could be based. First, every living thing absorbs and expends energy throughout its life span. Second, every living thing has a finite life span. These properties are common to all living substances from the single cell[1] to the largest animal. The desideratum is therefore a measurement which quantitatively unites these two properties, contains no other components, and is capable of being precisely determined.

Since the units of these properties are respectively energy and time, the physical concept of action suggests itself, for action is the product of energy and time. This choice is not adventitious, because action is one of the most important properties of inert matter. The macroscopic properties of inert things—gravitation, electromagnetic propagation, and mechanics—have been summed up in a single law, the Principle of Least Action; with the exception of entropy, action is the only invariant property that has survived the relativity theory; the curvature of space-time is determined by the action existing at each point in the universe; and finally, the most important quantity in atomic physics is a quantum of action—Planck's constant, h. Nature's emphasis on action strongly suggests it as a universal quantitative measure of life.

CALCULATION OF LIVING ACTION

Action is defined as the time integral of energy. Expressed mathematically it is

$$A = \int^{T} U\, dt, \qquad (1)$$

where U represents energy, T time interval, and A action. It has been shown by Rubner (*34*) and by Atwater and Benedict (*3*) that the Law of Conservation of Energy holds for living things to within 1 percent. Since the life span of a living thing can be measured very precisely, to within a fraction of 1 percent, its total action can be accurately determined by equation 1.

The energy expenditure of living things occurs at a finite rate, and it is this rate that is experimentally measured. Since

$$dU/dt = P, \qquad (2)$$

where P is power, equation 1 may be more conveniently expressed by

$$A = \iint^{T} P\, dt^2. \qquad (3)$$

Many forms of living power, such as input, output, loss, growth, and muscular power may be substituted for P, and each determines a corresponding form of living action. It is beyond the scope of this article to investigate all the power and action characteristics;

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[1] The life span of a cell may be defined as the interval from birth to mitosis, for no active cell exists indefinitely without undergoing some form of division.

the purpose here is merely to introduce an experimental basis for the application of action to the study of living matter. Calculations based on basal metabolism will serve to illustrate the technique and permit a preliminary investigation into the nature of the variation of living action. Basal metabolism is especially suited for this purpose since it is easily and accurately measured, fairly constant, and one of the most important physiological properties of life (*5*), and considerable data are already available.

The generally accepted definition of basal metabolism is used in this report—namely, the basal (standard minimum) energy consumed by the living thing per unit of time per unit of body surface area. Basal power is therefore the basal (standard minimum) energy consumed per unit of time. If basal power is represented by P_b and basal metabolism by M, then

$$P_b = MS, \qquad (4)$$

where S is body surface area. This definition of basal power is generally synonymous with the term total basal metabolism in the literature.

For small animals it is feasible to make direct metabolism measurements from birth to death to determine the individual's power characteristic. For large animals, and especially man, this method is impractical. An alternative is to determine the average characteristics of the species by means of a cross-section survey. The basal action of an individual can then be determined if the deviations of its life span and basal power from the average are known.

A study of basal metabolism well suited for the calculation of basal action is that made on Americans by Boothby, Berkson, and Dunn (*9*). Only basal metabolism values, M, were reported, however, so that it is necessary to know the surface area characteristic of the average individual to obtain the desired basal power characteristic, P_b. This is tantamount to obtaining the weights and heights of the average male and female American, since the surface area used by Boothby *et al.* was calculated from the DuBois and DuBois formula:

$$S = .007184\ W^{0.425}\ H^{0.725}, \qquad (5)$$

where W is the nude body weight in kilograms, H is the unshod standing height in centimeters, and S is in square meters.

Values of average weight, height, and basal metabolism for all ages are listed in Table 1, along with the calculated surface area, basal power, basal energy, and basal action. The results are shown graphically in Figs. 1–3.

The gap from 0 to 6 years in the report by Boothby *et al.* is supplemented by results from Benedict and Talbot (*6*). The latter report, one of the most complete for the infant period, is consistently low (*6, 32*).

TABLE 1

BASAL ACTION OF THE AVERAGE WHITE AMERICAN

Exact age, yrs	Weight, nude kg		Height, unshod cm		Surface area m²		Bas. met.* Cal/m²/hr		Basal power Cal/day		Basal energy g-cal × 10⁹		Basal action g-cal-Yr × 10⁹	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1.5					0.514	0.483	59.1	57.0	729	661			0.15	0.16
3.0	15.1	14.8	96.5	95.7	0.625	0.617					0.72	0.68		
4.5					0.731	0.724	54.9	51.7	964	899			2.34	2.22
6.0	21.6	21.4	117.7	116.7	0.840	0.832					1.78	1.66		
7.5					0.951	0.941	52.4	48.5	1194	1095			7.71	7.24
9.0	30.1	30.0	134.8	133.8	1.067	1.061					3.09	2.87		
10.5					1.182	1.190	48.0	45.7	1362	1305			16.99	15.87
12.0	40.0	42.2	149.8	151.1	1.301	1.341					4.59	4.29		
13.5					1.450	1.480	46.5	42.5	1618	1509			30.79	28.78
15.0	54.5	53.3	167.1	161.9	1.607	1.555					6.36	5.93		
16.5					1.733	1.588	45.5	38.6	1891	1471			49.91	46.57
18.0	64.6	56.1	175.2	162.9	1.790	1.599					8.41	7.54		
19.5					1.804	1.605	42.2	36.6	1829	1410			75.13	69.18
21.0	66.8	57.1	"	"	1.814	1.611					10.42	9.08		
22.5	67.4	57.6	"	"	1.821	1.617	40.9	36.1	1790	1400			106.37	96.42
27.5	69.3	59.1	"	"	1.844	1.634					14.68	12.41		
32.5	71.3	60.6	"	"	1.864	1.650	39.3	35.8	1760	1418			252.79	220.70
37.5	72.3	62.1	"	"	1.881	1.668					20.95	17.59		
42.5	73.9	63.6	"	"	1.893	1.685	38.0	35.5	1728	1437			461.68	396.59
47.5	74.3	64.9	"	"	1.902	1.700					27.25	22.31		
52.5	75.1	65.7	"	"	1.905	1.709	36.7	34.0	1678	1394			734.18	624.66
57.5	75.0	65.7	"	"	1.904	1.709					33.33	27.90		
62.5	74.9	65.1	"	"	1.903	1.701	35.5	32.7	1621	1337			1067.91	903.59
67.5	74.3	64.3	"	"	1.903	1.694					39.31	32.77		
72.5					1.903	1.686	34.1	32.1	1564	1299			1460.55	1281.24

* After Benedict and Talbot (*6*) (0–5.5 yr) and Boothby, *et al.* (*9*) (6.5–74.5 yr).

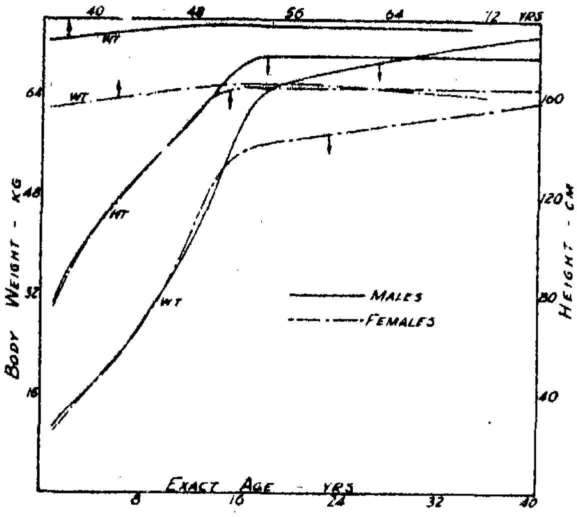

Fig. 1. Weight and height of average white American.

so that a correction factor has been applied. This factor for males and females is given in Table 2.

Eleven sources of average weights and heights (*1, 2, 4, 7, 10, 16, 18, 22, 31, 36, 38*), carefully chosen from the literature, provide the basis for the weight and height characteristics. These studies, which were selected for anthropometric accuracy, period in which the research was carried out, and type and number of subjects, fall naturally into two age groups: preadult and adult.

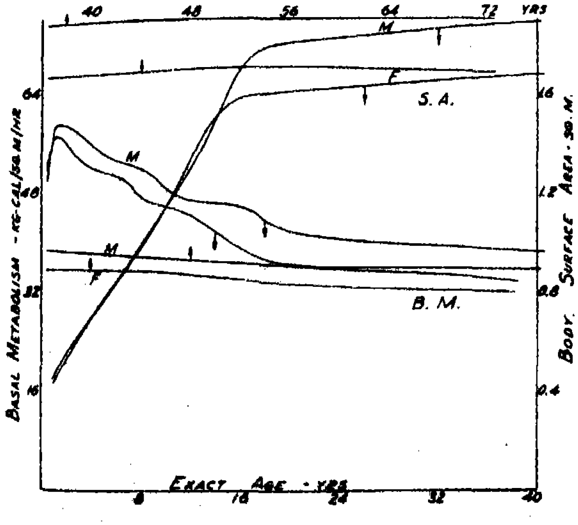

Fig. 2. Surface area and basal metabolism of average white American.

The preadult group is composed of five sets of averages from diverse sections of the United States (*1, 10, 16, 18, 22, 31*). The agreement among the sources is good. For the adult period, statistics available for this study are those of the *Medico-actuarial mortality investigation.* Although collected prior to 1910, these

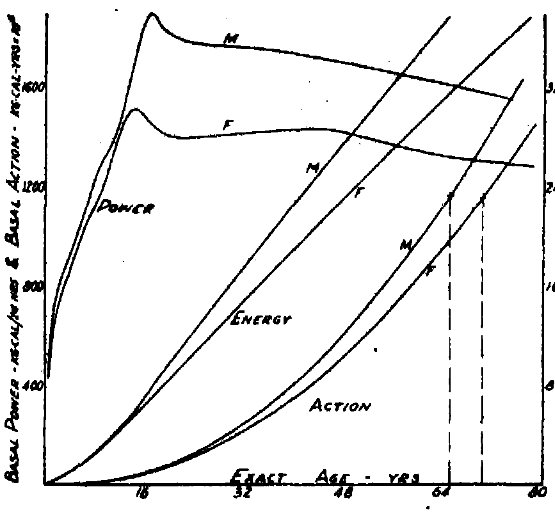

Fig. 3. Basal power, basal energy, and basal action of average white American.

insurance statistics give a reliable variation of adult weight and height with age which, it is assumed, is essentially similar for all generations. The adult and preadult weight curves fit smoothly because the insurance statistics were obtained with subjects clothed, thus counterbalancing the increased weight of the modern generation. The curves of Weisse (*36*) and the 1924 U. S. Army Officers examination (*7*) verify the shape of the adult weight-age curves. Adult height is assumed constant after maturation. This is confirmed by existing studies when allowance is made for their cross-sectional nature.

TABLE 2

Correction Factor for Determining Basal Metabolism of Children

Exact age yr	Basal metabolism Cal/m²/hr		Ratio other investigators : Benedict and Talbot
	Benedict and Talbot	Other investigators :	
		Females	
3.25	44.7*	53.7*	1.201
3.75	39.8*	53.8*	1.351
4.25	42.8*	51.7*	1.209
6.50	41.0‡	50.5†	1.231
7.50	40.5‡	48.5†	1.198
Average			1.238
		Males	
3.36	47.8‡	55.7*	1.166
3.79	47.3‡	54.7*	1.158
4.14	46.7‡	57.4*	1.229
6.50	44.4‡	53.0†	1.193
7.50	43.7‡	52.4†	1.199
Average			1.189

* After Robb (*32*).
† After Boothby *et al.* (*9*).
‡ Interpolated from curves of Benedict and Talbot (*6*).

The surface area characteristics are given by equation 5 and the basal power characteristics by equation 4. The basal power peaks at 17 and 14 years for the male and female respectively are due to a combination of high basal metabolism and rapid increase in size (surface area) in adolescence. The secondary peak in average female basal power at age 44 is undoubtedly connected with the menopause.

Integration of the power curves yields the energy curves; integration of energy yields the action curves. The integrations were accomplished by arithmetic summation of small age increments, the increment being one year to age 26, and two years past age 26.

The latest available life expectancy figures show male life expectancy for 1946 to be 65.1 years and female 70.3 years (*37*). Interpolating from the corresponding action data gives 1164.7×10^9 gram-calorie-years for the basal action of the average American male and 1154.1×10^9 gram-calorie-years for the average American female. The mean is 1159×10^9 gram-calorie-years, or 1.53×10^{27} erg-seconds.

INVARIANCE OF BASAL ACTION

Although this investigation demonstrates the calculability of living action, it gives no direct information on variation within the species. This variation is important, for the less it is, the more useful action will be as a quantitative tool. Pending direct experimentation, an insight into the nature of this variation may be obtained from a comparison of male and female basal actions.

If the life span of each individual is so related to its basal power that action is constant, i.e., so that equation 3 produces the same value for all members of the species, then variation in action would be zero and independent of the variations in P_b and T. On the other hand, if there is no correlation between P_b and T, then, since action is effectively power multiplied by life span, the variation in action, measured in terms of its standard deviation, σ_a, would be of the order of $\sqrt{\sigma_P{}^2 + \sigma_T{}^2}$. In this case σ_a is not zero and is greater than the standard deviation in P_b or T. The correlation between P_b and T may therefore serve as a measure of the invariance in action.

For zero variation in action, T and P_b must be inversely related in a manner determined by equation 3. Thus, an inverse relation between life span and power consumption is a sign of relative invariance in action, and the more this inverse relation approaches the one which produces constant action, the more invariant action becomes.

The greater male power consumption, approximately 15 percent, and the lower longevity, 7.68 percent, compared to females shows an inverse dependence of T upon P_b, at least for sex. The sex difference in action, on the other hand, is only 0.91 percent, or 8.4 and 16 times less than the sex difference in life span and basal power respectively. However, before considering the significance of this it is first necessary to make sure that the near equality of male and female basal actions is not a chance phenomenon but a real and significant result of the calculation.

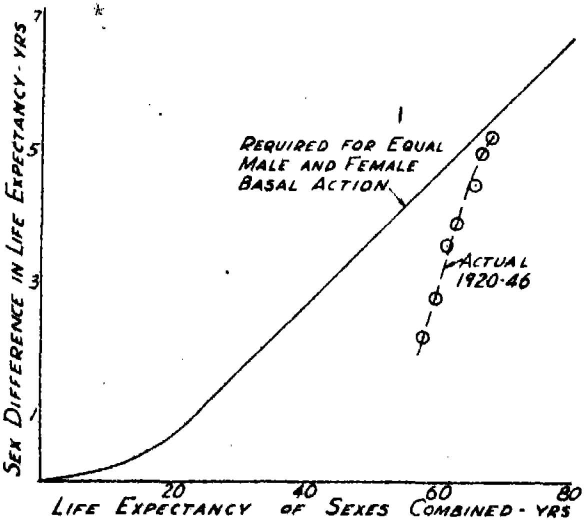

FIG. 4. Sex difference in life expectancy vs. life expectancy for average white American.

First, the reliability of the sex difference is greater than that of the actual values of basal action. Parallel studies of male and female metabolism, weight, and height were used throughout, so that inaccuracies due to the combination of different sources of data tend to cancel out in the sex difference. Thus the accuracy of the sex difference is not materially affected by errors introduced by the piecemeal method of calculation.

Second, the choice of life expectancy data is not critical. Both life span and size of the average American have increased in the last few decades. The increase in size is small and may be neglected here, but the increase in life span is appreciable. Its effect on the action sex difference is shown in Fig. 4. The solid line is obtained by assuming a value of action and determining from the curves of Fig. 3 the corresponding male and female life spans. The sex difference in life span is then plotted against the average of the two. The broken line gives the actual sex difference in life expectancy vs. average of male and female life expectancy for 1920 to 1946 (*14*, *37*). This shows that as average man approaches the potential life span of the species, i.e., that given by the life curve of old persons, the condition for equal male and female actions is also being approached. That there is a natural limit to the potential span of life is clearly indicated by life expectancy figures, for there has been no significant change in the life expectancy of old persons in the last half-century although average life expectancy has increased about twenty years (*24*). Furthermore, this natural limit has almost been attained by the 1946 group. The use of the 1946 life expectancy values is thus justifiable.

Third, the first or third integral of power may also have a significantly low sex difference as well as the second integral. Emphasis on action would then be unwarranted, despite the philosophical arguments in its favor. Actually, the values for the first integral of power (basal energy) for the 1946 group are 37.80 and 34.49×10^9 gram-calories for the male and female respectively, giving a sex difference of 9.16 percent. Similarly, calculation of the third integral of power (integral of action) yields a sex difference of 8.71 percent. These values, which are 10 and 9.6 times the action sex difference respectively are not small enough to be considered.

It is unlikely, then, that the near equality of average male and female action can be attributed to fortuitous circumstances. This poses the intriguing possibility that the inverse relation between average male and female power and life span is such that action is invariant within narrow limits. Although direct quantitative data of the kind required to generalize this hypothesis appear to be lacking at present, it is nevertheless possible to confirm the existence of a general inverse relation between power and life span which supports invariance of action for other species and conditions. For purposes of analysis, variation in power consumption is considered with respect to five factors: sex, race, climate, magnitude of power consumption, and shape of power characteristic. The effect of these upon life span is summarized as follows:

I. *Sex.*

A. In a series of experiments on *Daphnia magna,* MacArthur and Baillie found that the metabolic rate as measured by heart beat is higher and life span lower for the male, while the product of the two is approximately the same for both sexes (*19*).

B. Landauer and Landauer (*17*) studied the higher mortality rate of male chicks and reported that "There is ample evidence for the conclusion that the higher metabolic rate of males [of all species] is not compensated by a different organization of the organism, but is actually brought about by a more rapid or more continuous functioning of the organs and cells of the male body. . . . It appears that there are no observations which are inconsistent with [this] assumption."

C. Basal power of male rats is greater than that of females (*11*) whose life span is greater (*21*).

D. Male life span has been reported shorter for *Drosophila melanogaster* (*26*) and others (*20*), and male basal power greater for swine, cattle and sheep (*11*), and others (*20*).

II. *Race.*

A. The wild strain of *Drosophila* normally has a life span three times as long as the vestigial strain. Pearl controlled the environment of 3,632 flies of both types by administering no food after birth (*30*), and found that under the equivalent conditions, the vestigial strain, which is smaller than the wild type, lived slightly longer.

B. In man racial and national differences in metabolism exist, but life span data are not equivalent except when two or more races, nations, or peoples exist side by side under the same conditions. The Jews, for instance, are one of the smallest peoples (*13*) and hence have a low basal power, but are also noted for their longevity (*33*).

III. *Climate.*

A. MacArthur and Baillie found that temperature had a profound effect on the length of life of *Daphnia magna* (*19*). The mean life span of both sexes was increased over four times for both sexes by a 20° C decrease in environmental temperature.

B. In cold-blooded animals increase of environmental temperature increases both metabolic rate and rate of senescence (*12*).

IV. *Magnitude of Power Consumption.* The components of basal power, surface area (size), and basal metabolism may each independently affect life span.

A. Effect of size.

1. Life insurance companies have carefully studied the relation of size to life span for many decades. One reports (*39*): "Studies show that body girth and length of life vary inversely with each other. . . . Overweight is distinctly detrimental to health and tends to shorten life."

2. The majority of centenarians are small in size and are frugal eaters (*33*).

B. Effect of metabolism. Physical and psychic factors may affect basal metabolism.

1. Physical exertion.

a) Slonaker found that voluntary exercise in albino rats decreased the life span 18.8 percent compared to a control group that was given no facilities for exercise (*35*).

b) In an exhaustive study, Pearl discovered that continued hard labor reduces the life span after the age of 40, but not before (*27*). Since his subjects were insured persons who had been in their respective occupations most of their lives, these in hard-working occupations always had an above-normal power consumption, and hence used up their supply of action at an early age. It is interesting to note that, since deaths of healthy but hard-working persons begin to occur at the age of 40 and not before, as Pearl found, then the maximum sustained physical exertion that normal man can tolerate over a long period of time increases power consumption to such an extent that the normal value of action, and consequent death, are attained soon after the age of 40. Any greater exertion would presumably incapacitate the worker early in his career and prevent further labor at this extreme rate.

2. Psychological factors affect basal metabolism through the reaction of the endocrine system.

a) Pearl, in a study of more than 2,000 individuals who lived to the age of 90 or more (*25*), was able to find only one significant trait among them, outside of their longevity, wherein the group differed from the rest of mankind as a whole: their calm mental make-up. They all were possessed of a placid temperament, were relaxed, and were rarely worried.

b) Brody points out that mental factors causing insecurity and tension shorten the duration of life in many ways (*12*).

c) Married persons live considerably longer than unmarried persons (*8*). The security and regularity of wedded life probably reduce the tension and insecurity that more often accompany the single state, as psychoanalysts and sexologists assert, with a consequent increase in life span of the average married person.

d) Urban dwellers have a much lower life expectancy than rural people, although the gap is gradually decreasing (*15*). An explanation of this difference may lie in the greater excitement and uncertainty of city life, a major sociophysiological difference between rural and urban life. The fact that newspapers, rapid transport, movies, and the radio are gradually bringing the tension and competitiveness of modern life to rural regions probably accounts for the lessening of the gap.

C. For single cells, it is a well-known cytological fact that, in general, increase in food consumption of cells produces a decrease in life span (interval between successive mitoses), and vice versa.

V. *Shape of the Power Characteristic.* Since action is the double integral of power, variations in the power characteristic in early life, owing to retarded or accelerated growth, for instance, must have a large effect on the life span if action is constant.

A. McCay and Crowell retarded the growth of rats, using a normal balanced diet but a limited calorific intake until maximum growth was attained (*21*). As a result, the life span of the group increased considerably with respect to a control group. Males benefited more than females, probably because male power consumption decreased more from its norm.

B. In the same article, McCay and Crowell report the results of experiments on brook trout whose rate of growth was restricted by limitation of their protein intake to a very low level. As a result, the life span of the trout increased to twice its normal value.

C. Northrop (*23*) has shown that the life span of fruit flies depends upon the rate of growth (length of time in the egg-larval-pupal period).

D. In experiments on cantaloupe seedlings, Pearl and his associates found the duration of life to be inversely proportional to the rate of energy expenditure during the growth of the seedlings (*28*).

E. Besides variations in rate of growth, there may be alterations in the shape of the power characteristic caused by prolonged illness. Generally, illness causes a reduction in activity, food intake, and weight, thus bringing basal power to a lower level. Pearl, in his study of the long-lived, found an abnormally large number who had been ill for a long period (*29*). Morbidity and mortality are totally different phenomena, and are often inversely related.

The primary requirement of any measuring rod is that it must be accurately obtainable. There are at least three major methods of determining the power properties of living things: by controlling or measuring the calorific intake, by obtaining the heat output, and by analyzing the respiration. All three methods are well known, and with careful application are amenable to very accurate evaluation, comparable to that obtained in the physical sciences. When power is combined with life span to form action, the resultant is still accurate, since life span can be measured precisely.

Either indirect (cross-sectional) methods, where a large number of subjects are studied in a short period, or direct (longitudinal) methods, where the same individual is followed throughout his life span, may be used. The choice depends largely upon the life span of the species being studied. Plants, insects, and small animals may be readily followed from birth to death, under conditions which simulate the natural environment of the species, by confining one or a specified number to a calorimeter or airtight chamber, or by administering a measured diet. With longer-lived species this becomes impracticable and the indirect cross-sectional technique must be resorted to. Cells, which should make very convenient subjects because of their short life span, may be readily studied directly under the microscope, or by the cross-sectional technique *in vitro*. A whole series of indirect experiments which quantitatively measure the relation between power and longevity is also possible, such as those based on the starvation and seedling experiments of Pearl, exercise tests of Slonaker, and rate of growth tests after Northrop, and McCay and Crowell. In sum, experimental possibilities for measuring living action are diverse, and cover the entire range of living phenomena.

The applicability of action to all forms of living matter suggests its use as the basis of a precise taxonomic scale, for the species may be arranged in ascending order according to their action values. At first this may seem ambiguous, since the elephant, which has a greater power consumption than man but a comparable life span, would be higher on the scale. The complexity of the nervous system, however, appears to be the most important factor in evolution, so that nerve action (or cerebral action) based upon the power consumed by the nervous system (or cerebrum) may be the most desirable action property for expressing the phylogeny of the species. It should be feasible to study evolution as a function of the characteristic nerve or cerebral action of each species.

The flexibility of living action is an important feature from an experimental point of view. Biologists and physiologists often have to deal with certain portions, rather than the whole, of the living thing. Since each cell may be represented by a finite action, any group of cells may also be represented by a finite action. This enables the experimenter to determine the action associated with any portion of the body, such as heart, eye, reticulo-endothelial system, or glands, which may also be extended to determining the intensity of a disease, calculating the action associated with tumors, cancers, and other abnormal conditions, and even to measuring the magnitude of epidemics occurring in the species as a whole.

The different forms of action also have special significance. Basal action is based upon the minimum power consumption required just to maintain life and therefore is probably related to the basic processes of species organization; output action, based upon power output, represents the "action" of the individual on the universe, and therefore has physiological significance when viewed with respect to muscular work, and social significance when regarded in terms of the work performed; total action measures the amount of energy-time absorbed from the outside world and is consequently indicative of the "action" of the universe on the individual; nerve and cerebral actions, as mentioned, are associated with evolution; loss action, obtained from internal power losses of the body, are probably connected with senescence and death; growth action, based upon power expended for growth, should yield information pertinent to the study of pediatrics, child development, and husbandry; and so on.

Because of the predominant role of the nervous system in living things, nerve action has interesting possibilities as a measure of mental and nervous phenomena. It is significant that the reaction of a neuron to a stimulus is of the nature of a constant of action, generally measured as an action potential. Unlike most other types of body cells, nerve cells that die are irreplaceable. If the inherent action of neurons is fixed, then the life span of each nerve cell is dependent upon the number of times it is stimulated. The death of critical nerve cells may thus precipitate senescence and ultimately lead to death. Which cells are the critical ones, and how their action may be extended, are subjects warranting investigation.

Nerve or cerebral action may also be used as a psychological tool. Associations and motor patterns are created by a finite system of nerve cells, as corroborated by the existence of the learning curve. The energy-time relation for the creation of these patterns and associations may therefore be represented by a finite quantity of action, so that mental phenomena, such as the formation of a neurosis or psychosis, memorization, habits, and learning, may be assigned a definite magnitude. This magnitude can be measured, since it is dependent upon the quantity of external action producing the stimuli. The cerebral action associated with the learning of a maze by a rat, for instance, is dependent in part upon the energy and time the rat spends in the maze.

It is evident that the mere calculability of action permits many applications, regardless of variation within the species. It is also evident, however, that if living action proves to be relatively invariant its usefulness will be greatly enhanced. All characteristics of life have some variation, and it is very unlikely that there is no variation whatever in living action. The evidence is admittedly inconclusive, but the near equality of average male and female basal actions and the existence of a general inverse relation between power and life span point to a relative invariance at least for basal and total actions. These findings indicate that the combination of power and life span to produce action is not factitious, and may have a natural origin.

Constancy of basal or total action affords a means for predicting life span. This technique is not entirely novel; insurance companies have been using it indirectly for some time in correlating size and longevity. It is also a common observation that the rate of living is inversely proportional to life span, as Rubner, Pearl, Brody, and other scientific investigators have realized for some time. But the possibility that action is the determinant may lead to more refined predictions. In this context, constancy of action would mean that a gain in longevity at the expense of power consumption is not real gain, but only a relative one, and that efforts to extend the existence of a living thing should be directed toward increasing its total action.

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TECHNICAL PAPERS

Plant Growth-regulating Properties of Some Nicotinium Compounds

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Six related nicotinium compounds have been found to possess growth-regulating properties when tested on bean plants. These include: parachlorobenzylnicotinium chloride, 2,4-dichlorobenzylnicotinium chloride, 3,4-dichlorobenzylnicotinium chloride, orthochlorobenzylnicotinium thiocyanate, benzylnicotinium bromide, and orthochlorobenzylnicotinium bromide. Applied to bean plants, these compounds brought about a reduction in stem elongation without typical gall formation or other form changes commonly observed in the use of other plant growth-regulating chemicals. The compounds were systemic in effect when applied to stems. The effects were expressed by illuminated plants as well as by others grown in darkness.

2,4-Dichlorobenzylnicotinium chloride (2,4-DNCl) was the most effective, ½ mg per plant greatly inhibiting elongation of plants grown in darkness and to a lesser degree the elongation of illuminated ones.

To test the effect of 2,4-DNCl on plants subjected to darkness, potted snap bean seedlings of the Black Valentine variety, germinated in a greenhouse, were selected for uniformity at a stage of development when only the hypocotyls were exposed above the surface of the soil. Half of the plants were treated by applying approximately

50 mg of lanolin paste containing 20% of Tween 20, 79% of lanolin, and 1% of 2,4-DNCl. The mixture was spread as a band about 5 mm wide around each hypocotyl. The remaining plants were left untreated and both groups placed in darkness. Extension of stems of the treated ones was retarded a noticeable amount during the first 48 hr following treatment, but there was no apparent effect on their diameters. There was a marked difference in the length of the hypocotyls and of the first internodes of the treated and the untreated plants (Fig. 1).

At the end of 13 days hypocotyls of treated plants were approximately half as long as comparable parts of untreated ones. First internodes of treated plants were about one-fourth the length of comparable parts of the untreated seedlings. Leaves of treated plants were equal to or slightly larger in size than those of untreated plants. Treated seedlings grown in darkness for 10 days were comparable in appearance to vigorous field-grown plants of a similar age, except that they were not green in color, while untreated ones showed the spindly growth expected in plants grown in darkness.

After 13 days of darkness, the average fresh weights of hypocotyls, first internodes, third internodes, and terminal buds of treated plants were significantly less than comparable parts of untreated plants. In contrast, the fresh weight of primary leaves of treated plants was 28.2% greater than that of primary leaves of untreated ones. The total fresh weight of the aboveground portions of treated seedlings was 12.3% less than that of the untreated.

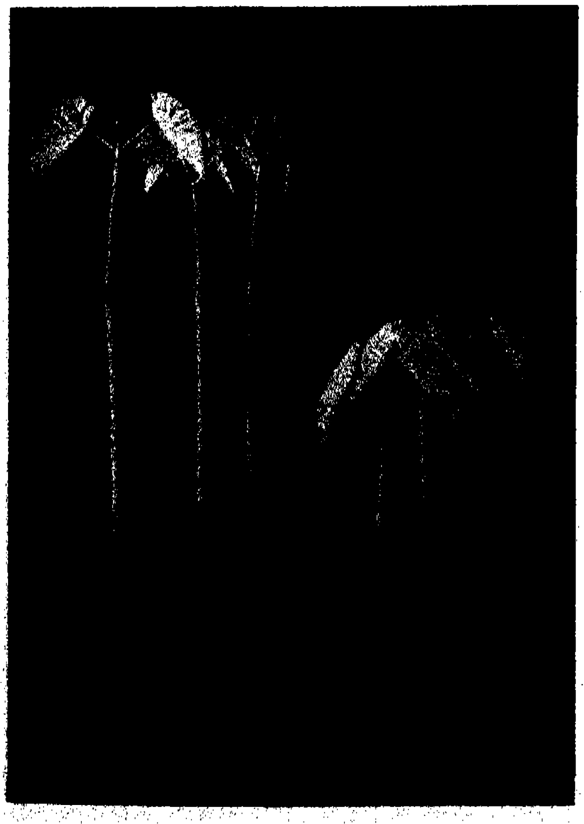

FIG. 1. At left, elongated stems of Black Valentine bean seedlings grown in darkness; compared with short thick stems that developed on comparable plants at right, treated with 2,4-dichlorobenzylnicotinium chloride. Plants grown in complete darkness and photographed 120 hr after treatment.

TABLE 1

LENGTH AND THICKNESS (IN MM) OF STEMS OF ILLUMINATED BEAN SEEDLINGS TREATED WITH RELATED NICOTINIUM COMPOUNDS COMPARED WITH THAT OF UNTREATED PLANTS

Treatment	Hypocotyl	First internode	Second internode	Total height	Diam of second internode
Untreated	95	62	41	246	2.42
Parachlorobenzylnicotinium chloride	94	34*	28*	186*	2.91*
3,4-dichlorobenzylnicotinium chloride	86	30*	20*	176*	3.09*
2,4-dichlorobenzylnicotinium chloride	81	25*	17*	148*	4.49*
Benzylnicotinium bromide	95	33*	33†	208†	2.74*
Orthochlorobenzylnicotinium bromide	81	33*	25*	176*	3.00*
Orthochlorobenzylnicotinium thiocyanate	80	39*	22*	168*	3.15*

* Significantly different from control at 1% level.
† Significantly different from control at 5% level.

In testing the effect on the growth of illuminated plants, Black Valentine bean seedlings were selected for size and uniformity and divided into groups. One group was left untreated and designated controls. Each of the others was treated by applying approximately 50 mg of the above lanolin paste containing, separately, the six nicotinium salts, as a band around the first internode of each plant.

Length of the hypocotyls was not affected (Table 1), but all treatments resulted in a highly significant reduction in the length of the treated portion of the stems (first internode). The most marked effect (59.7% reduction) resulted from the application of 2,4-DNCl. All treatments brought about a significant reduction in length of second internodes and in the total height of the plants. 2,4-DNCl was most effective in reducing the over-all height (66.1% less than control) and benzylnicotinium bromide was least effective in this respect.

All of the compounds used brought about a significant increase in the diameter of the stems, the greatest increase (85.6%) resulting from the application of 2,4-DNCl.

A group of bean seedlings was selected for uniformity and used to test the effect of 2,4-DNCl when applied to different parts of the plant. Fifty mg of lanolin paste (containing 0.5 mg of 2,4-DNCl as previously described) was applied to each plant. Plants in respective groups were treated by applying the paste either as a band around the hypocotyl, as a band around the first internode, as a thin layer along the midrib of one primary leaf, or as a thin layer on the cotyledons of each plant. Comparable controls were similarly treated with lanolin containing 20% of Tween 20 but no 2,4-DNCl.

Ten days after treatment there were marked differences in the way the plants had responded. Treatment of the first internode reduced stem length by 33.5%. An equal amount of 2,4-DNCl applied to the hypocotyl reduced stem length by 22.8%, while the same amount of chemical applied to the leaf brought about only a 7% reduction in stem elongation. Treatment of the cotyledon had no significant effect on stem elongation, although the cotyledons were fleshy when treated and remained attached for several days following treatment. It is obvious from these results that the effectiveness of 2,4-DNCl in inhibiting internodal elongation varied, depending upon the part of the plant treated.

Bean plants in different stages of development were used to compare the effect of 2,4-DNCl on stem elongation of plants in different stages of maturity. Seedlings selected for the first group were about 3 in. tall and their hypocotyls were still increasing in length. Plants in the second group were 4–5 in. tall, their hypocotyls had nearly completed elongation, and the first internodes were elongating. Plants in the third group were 6–7 in. tall, the hypocotyls had reached maximum length, and the first trifoliate leaf was beginning to unfold. Part of the plants in each group were treated by applying 50 mg of the paste containing 2,4-DNCl as a band around the hypocotyl of each plant. The remaining plants in each age group were left untreated for comparison.

During the following 10 days, stem elongation of the youngest treated plants was reduced by 35.8% and of those in the medium age group by 28.6%, whereas treatment of the oldest plants reduced stem length only 6.2% in comparison with elongation of comparable untreated plants in each age group.

With respect to molecular configuration of the compounds used, there was a statistically significant difference between the activity of the three chlorides. Parachlorobenzylnicotinium chloride was least effective, 3,4-dichlorobenzylnicotinium chloride was somewhat more effective than the para form, and 2,4-dichlorobenzylnicotinium chloride was very effective in reducing internodal elongation. The three compounds assumed the same order of activity when classified on the basis of their effect on stem diameter. Differences between the activity of the compounds evaluated on this basis were highly significant from the statistical standpoint.

With respect to the two bromides used, the substitution of one chlorine atom in the ortho position in the benzene ring significantly increased activity when evaluated either on the basis of the inhibition of stem elongation or increase in stem diameter.

In preliminary experiments the following coal tar derivatives[1] have been found to bring about responses in bean plants similar to those that resulted when the nicotinium compounds were applied: 2,4-dichlorobenzylpyridinium chloride, 2,4-dichlorobenzyl-2-picolinium chloride, 2,4-dichlorobenzyl-3-picolinium chloride, and 2,4-dichlorobenzyl-4-picolinium chloride. The effect of these coal tar derivatives on plant growth is being studied further.

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[1] Coal tar derivatives prepared by Dr. C. F. Woodward and Dr. D. H. Saunders, Eastern Regional Research Laboratory, Wyndmoor, Pennsylvania.

Conduction in Photoconductive PbS Films

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Sosnowski, Starkiewicz, and Simpson (*2*) have produced photoconductive PbS films which contain both Pb and O atoms as impurities, in concentrations ($10^{19}/cm^3$) that are, for semiconductors, relatively high. The Pb and O atoms tend to make the film an *n*-type or *p*-type semiconductor, respectively. Photoconductive sensitivity demands a very careful balance of these impurities to make the conductivity a minimum; this occurs, presumably, when Pb and O impurities are present in equal numbers. Variations in the densities of the two impurities will then cause the film to consist of *p* and *n* regions interspersed. The very high resistance of the film is attributed to the *p-n* barriers, and the photoconductive effect to the reduction in height of these barriers by the redistribution of electronic charge produced by illumination (photovoltaic effect).

This note presents some extensions of these ideas, and conclusions as to the film structure desired for maximum photosensitivity.

First, it must be noted that purely random fluctuations in the densities of the two types of impurities can produce important fluctuations of the conductivity and potential within the film. Consider, for instance, the most homogeneous possible film containing 10^{19} O atoms and 10^{19} excess Pb atoms per cm^3. A 1-μ cube will then contain about 10^7 atoms of each type. Random fluctuations in these numbers, from cube to cube, will be of the order of $\sqrt{10^7}$. The excess of one impurity over the other (net impurity density), which determines the character of the conduction in a region, will be on the average some $\sqrt{2 \times 10^7} = 4.5 \times 10^3$ atoms, or about the number of impurity atoms in an equal volume of an ordinary semiconductor with 5×10^{15} impurities/cm^3. For larger regions the fluctuations in net impurity density will be less; in smaller regions the potential fluctuations discussed in the next pararaph cannot follow closely the fluctuations in impurity density. The "homogeneous" film considered here will thus in effect consist of *n* and *p* regions, of the order of 1 μ in diameter, with conductivities ranging from the intrinsic level to values of the order of those produced by 10^{16} impurities of one type per cm^3.

Fluctuations in net impurity density may cause important fluctuations of potential in the film, even when they do not involve the appearance of *n-p* barriers. In an ideal homogeneous semiconductor the Fermi ζ-level is extremely sensitive to changes in the relative numbers of *n* and *p* impurities, when these are present in nearly equal numbers. At low temperatures this sensitivity is particularly great: a very small preponderance of one impurity over the other will shift the ζ-level to the neighborhood of the corresponding impurity level. In an inhomogeneous semiconductor in equilibrium the ζ-level is fixed, but the electrical potential undergoes corresponding fluctuations as the relative number of impurities shifts. The variations in potential will be larger the lower the temperature (Fig. 1a, b) becoming important when the number of thermally excited carriers falls below the net impurity density. Taking the width of the forbidden band in PbS as 0.385 ev, and the effective electronic mass equal to the real electronic mass, one finds the number of intrinsic electrons to be $1.5 \times 10^{16}/\mathrm{cm}^3$ at 300° K, and $2.16 \times 10^{15}/\mathrm{cm}^3$ at 250° K. In the film considered above, the potential fluctuations would become important around room temperature, and would increase significantly with decreasing temperature through the next 100° C.

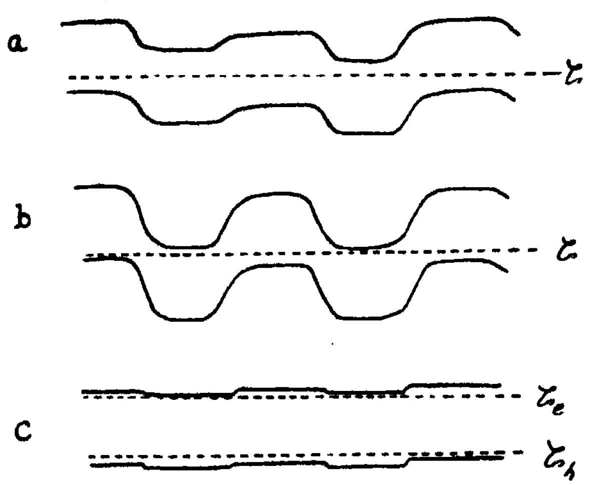

FIG. 1. Schematic representation of edges of forbidden band between the full band and the conduction band. (a) Moderate temperature, no illumination. (b) Low temperature, no illumination. (c) Strong illumination.

With inhomogeneous materials, the conductivity of films may be very different from that of bulk material. In either case charges will tend to move through potential valleys, along paths of minimum potential change: in the films here considered current will flow most easily along chains of *n*-regions or of *p*-regions. A film of thickness 1 μ will be essentially one region thick, and current flow in it will be essentially two-dimensional. If *n*- and *p*-regions are present in equal numbers, the probability that there will exist a continuous *n*-path across a region in the direction of current flow is equal to the probability that there will be a continuous *p*-path at right angles to it. These two events are mutually exclusive, and each will occur with very small probability if the region considered is large. Only when one type of region is present in considerable excess will continuous *n*-paths or *p*-paths be available in the film; in other cases *p*-*n* barriers must be traversed by the current. In bulk material, on the other hand, there can simultaneously exist networks of *p*- and *n*-regions along which conduction can take place, even when the two types of regions are present in equal numbers. If inhomogeneities in PbS arise only from fluctuations, the conductivity of a film will be of a lower order of magnitude than that of the bulk material when the two types of impurity are present in equal amount; the two conductivities will, however, be comparable when one type of impurity is so much in excess that fluctuations will not cause the appearance of regions of opposite type.

It is thus evident that PbS films with large, equal numbers of Pb and O impurities will have high resistances, because (a) the number of conductors in any given region depends on the net, rather than the total, impurity concentration; and (b) *p*-*n* barriers, as well as smaller fluctuations of potential, impede the flow of current. The conductivity decreases with decreasing temperature because the number of available conductors is decreased, but, more importantly, because the potential barriers become higher. Inequality in the average density of *p*- and *n*-impurities will decrease the importance of the density fluctuations, and decrease the potential fluctuations, as well as increase the number of carriers. Maximizing the resistance of the film, as described in reference *2*, thus provides a very sensitive means of assuring equality in numbers of the two types of impurities, especially if the resistance is measured at a low temperature.

This picture of the conductivity of PbS films is supported by the observations of Chasmar (*1*), who found that the resistance of the films falls with increasing frequency, because of capacitative shorting of the *p*-*n* barriers. The high frequency conductivity, due to current flow within individual regions, remains of the order of a thousand times less than that of other PbS semiconductors. This is due to the fact, apparently overlooked by Chasmar, that the conductivity of the individual regions depends on the carefully minimized difference in concentrations of the two impurity types; it would be a thousand times greater if one impurity or the other were absent.

Illumination of the PbS film increases the number of electrons in the conduction band and of holes in the full band, throughout the material. The distribution in energy of the holes and electrons will not, however, be the same as if this effect were produced by rise in temperature. Indeed, if interactions of electrons and holes with the lattice are sufficiently frequent (as compared with the creation and annihilation of holes), the distribution in energy of holes alone, and of electrons alone, will continue to be those corresponding to the temperature of the crystal lattice. The probability that an electronic state, or a hole state, will be occupied can then be written, as usual, as

$$p(\varepsilon) = \left[e^{\frac{\varepsilon - \zeta}{kT}} + 1 \right]^{-1},$$

but it will be necessary to take different ζ-values for the holes and for the electrons. As the number of electrons and holes is increased by increasing illumination, these ζ-values approach the edges of the conduction and full bands, respectively, whatever the impurity density. Since each of these ζ-levels will be constant through the crystal, this involves a leveling-out of the potential fluctuations (Fig. 1c), which will become marked when the concentration of holes and electrons introduced by illumination becomes comparable with the net concentration maintained by impurities and thermal excitation. This leveling of the potential barriers, and the attendant decrease in resistivity, will thus occur for lower illumination the more exact the balancing of the two types of impurities, and the lower the temperature. The observation of Chasmar (*1*), that high frequency conductivity is little affected by illumination, indicates that this, rather than any increase in the number of available carriers, is the important factor in the photoconductivity of these films. Very pure PbS films should also show photoconductivity, their low intrinsic conductivity being increased by the carriers produced by illumination; their sensitivity to illumination, should, however, be markedly less.

It appears, then, that high photosensitivity of PbS films is to be sought by careful balancing of fairly high contents of *n*- and *p*-impurity atoms in films of the order of 1 μ thick, made as homogeneous as possible; random fluctuations in impurity distribution will suffice to produce the required potential fluctuations in the film. Use of the films at low temperatures is also indicated.

A theoretical study of the potential distribution and conductivity in these films, as it depends on temperature and illumination, is now in progress.

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On the Direct Fermentation of Maltose[1]

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During the course of isolating and identifying bacteria of the genus *Neisseria* from the nasopharynx of humans, several strains were encountered which fermented maltose with acid production while glucose was not fermented. The fermentation of a disaccharide without fermentation of either of its constituent monosaccharides (direct fermentation) by bacteria has been reported by Wilson and Smith (*5*). Wright (*6*), Douderoff *et al.* (*1*), and Snell *et al.* (*3*), have reported on a strain of *Lactobacillus bulgaricus* which utilized lactose but not glucose or galactose. such observations are not in accord with the generally accepted concept of indirect fermentation, which presupposes a cleavage of the disaccharide to its monose constituents, which are fermented as such. The subject of direct and indirect fermentation has been reviewed by Liebowitz and Hestrin (*2*).

TABLE 1

pH Values Produced in Glucose and Maltose Broth by Several Strains of *Neisseria*

Culture	Media*	
	Glucose broth	Maltose broth
	pH	pH
No. 4	8.3	6.0
" 12	8.1	5.7
" 55	8.3	6.3
" 876	7.9	5.6

* BBL phenol red broth containing peptone and meat extract, pH 7.2–7.4. The glucose and maltose were sterilized by filtration and added aseptically to sterile phenol red broth to give a final concentration of 0.5%. The pH values were determined after 7 days' incubation at 35° C.

The results obtained with four cultures of *Neisseria*, when cultivated in glucose and maltose broth, are shown in Table 1. In each instance, the organisms produced acid from maltose while an alkaline reaction developed in the glucose medium. It may be noted that an acid reaction in the vicinity of pH 6.0 is a limiting factor for the growth of most *Neisseria*.

Further observations were made comparing culture No. 12 to a strain of *Neisseria sicca*, which ferments both glucose and maltose. Each of these organisms was cultivated in glucose and maltose broth for a 5-day period, after which the residual sugar was determined by the method of Somogyi (*4*). The culture of *N. sicca* effected complete utilization of both carbohydrates, while culture No. 12 utilized approximately 75% of the maltose and little, if any, of the glucose. In addition, experiments employing the Warburg manometric technic showed that the oxygen uptake with cells of *N. sicca* was approximately the same for both glucose and maltose. For culture No. 12, the oxygen uptake with maltose was approximately that obtained with *N. sicca*; with the glucose, the uptake was only slightly greater than that of endogenous respiration.

The maltose used in the above experiments was chemically pure (Pfanstiehl). All determinations have been repeated using maltose recrystallized from chemically pure maltose and treated with norite five times. No differences in results were obtained.

These results suggest that the *Neisseria* described are capable of a direct fermentation of maltose.

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[1] Supported in part by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service.

Thymidine and Vitamin B_{12}*

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Thymidine as a growth factor for certain lactic acid bacteria has received attention recently because of a possible metabolic relationship with vitamin B_{12}. Since thymidine can replace vitamin B_{12} in the nutrition of *Lactobacillus lactis* Dorner and *L. leichmannii* 4797, Wright *et al.* (*5, 9*) have suggested that vitamin B_{12} may be a coenzyme in the synthesis of thymidine from thymine. Shive (*4*) points out that conversely thymidine may be involved in the synthesis of vitamin B_{12}.

TABLE 1

Comparison of Growth-stimulating Properties of Thymidine, Vitamin B_{12}, Liver Concentrate, Thymine, and Folic Acid

10 ml Basal medium plus:			Galvanometer reading*			
thymidine	thymine	other supplements	*Streptococcus faecalis* R	*Leuconostoc citrovorum* 8081		*Lactobacillus leichmannii* 313
			30° C	37° C		37° C
γ	γ		17 hr	16 hr	40 hr	24 hr
0	0	0	98	98	95	83
0	0	10 mγ folic acid	36			
50	0	0	30			
0	50	0	30			
0	0	1–10 mγ B_{12}	97			
0	0	0.01 ml liver concentrate		58	39	
40	0	0†		37	35	
40	0	2 mγ B_{12}		35	39	
0	0	0.1–100 mγ B_{12}		98	95	
0	40–8000	0†		99	95	
0	40, 800	2 mγ B_{12}		96	95	
0	0	2 mγ B_{12}‡				88
0	0	2 mγ B_{12}				44
0	0	0.0012 ml liver concentrate				41
20	0	0†				47
0	20, 200	0				80
0	20, 200	2 mγ B_{12}‡				61

* Turbidity of cultures measured in an Evelyn colorimeter, 660-mμ filter, with an uninoculated tube containing the 10-ml assay volume of basal medium set at 100.

† Growth was the same in presence or absence of folic acid. ‡ Folic acid omitted from medium.

As crystalline vitamin B_{12} (*2*) is now available for experimental use, it seemed desirable to investigate further this presumed relationship of thymidine to vitamin B_{12}, using three strains of lactic acid bacteria, all of which respond to thymidine but which vary in their response to other growth-promoting agents. The microorganisms chosen were *Streptococcus faecalis* R, *L. leichmannii* 313, and *Leuconostoc citrovorum* 8081.

The basal medium for *S. faecalis* R was that of Tepley and Elvehjem (*8*), which contains no folic acid but does contain 100 γ per 10 ml of adenine, guanine, xanthine, and uracil. The basal medium for *L. leichmannii* and *L. citrovorum* was that described by Snell *et al.* (*6*) in which there is 100 mγ folic acid per 10 ml as well as adenine, guanine, and uracil in the same concentrations as above. For *L. citrovorum* the Tween 80 and oleic acid ordinarily present were omitted. In this medium an increase in pH from 6.0 to 6.5 affected adversely the response of *L. leichmannii* to vitamin B_{12}. As *L. citrovorum* grows equally well at pH 6.0 and 6.5, the medium was adjusted to pH 6.0 for both microorganisms. The following supplements were used in the assays: crystalline vitamin B_{12},[1] a commercial liver concentrate containing 15 U.S.P. units of antipernicious anemia factor[2], thymidine,[3] thymine,[4] and crystalline folic acid.[2]

In the case of *S. faecalis* R there was no response in 40 hr to vitamin B_{12}, while in 16 hr thymidine and thymine fully replaced the requirement for folic acid in the ratio of 5000: 1, as described earlier by Stokes (*7*).

Both thymidine and one or more factors in liver supported growth of *L. citrovorum* to the same degree, but as reported previously (*5*) the response to thymidine was characteristically delayed 21–40 hr. Attempts to replace the liver preparations or thymidine with vitamin B_{12} were repeatedly unsuccessful. The response of *L.*

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* Since this report has been submitted for publication, Lyman and Prescott have also indicated that the liver factors for *L. leichmannii* and for *L. citrovorum* are not identical. (*J. biol. chem.*, 1949, 178, 523).

[1] Vitamin B_{12} supplied by Merck & Co.

[2] Supplied by Lederle Laboratories.

[3] Thymidine supplied by Dr. D. W. Woolley of Rockefeller Institute.

[4] Supplied by Schwarz Laboratories.

citrovorum to thymidine in the presence of vitamin B_{12} was the same quantitatively and qualitatively as that with thymidine alone. Thus the liver activity could not be replaced by thymidine or vitamin B_{12}, or by a combination of the two. As indicated in Table 1, thymidine supported growth equally well in the absence of folic acid. Of particular interest was the negative response of *L. citrovorum* to thymine in the presence of vitamin B_{12}.

L. leichmannii responded promptly to vitamin B_{12} in amounts ranging from 0.05 mγ to 2 mγ, at which level there is a maximal response with this strain. The growth-promoting effect of liver appeared to be due to its vitamin B_{12} content. Thymidine, in the presence or absence of folic acid, supported growth comparable in amount to that produced by vitamin B_{12} only in the presence of folic acid. Thymine could substitute only partially for the folic acid requirement of this microorganism. Similar results have been reported by others (*1, 4, 5*).

Although thymidine and vitamin B_{12} can replace each other in supporting growth of *L. leichmannii*, the nature of the data obtained with *L. citrovorum* and *S. faecalis* R does not indicate a specific thymidine-vitamin B_{12} relationship.

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Partition Chromatography of Anthocyanidins[1]

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Because of the recent reports of Bate-Smith (*1, 2*) which have been concerned with partition chromatography of anthocyanins and anthocyanidins on filter paper, it seems advisable to make a preliminary report of our progress in this field.

In the course of some work with the coloring matter of wine and grapes, it became necessary to develop a method for the separation and quantitative analysis of an anthocyanidin mixture. We thought that separation might be accomplished by a modification of the partition chromatography method of Martin and Synge (*5*). The anthocyanidins, malvidin and petunidin, were synthesized according to the methods of Robinson and co-workers (*3, 4*).

When solutions of these two pigments in a mixture of one volume of *n*-butanol and three volumes of ethyl ether were shaken with 10% *ortho*phosphoric acid, almost all of the pigment was transferred to the aqueous layer. An 8.1-cm column was prepared in the usual way (*5*) from 2.38 g of silicic acid (Eimer and Amend precipitated *meta*silicic acid; reported iron content less than 0.006%; reported heavy metal content 0.00%; dried at 100° C), 1.32 ml of 10% *ortho*phosphoric acid, and a mixture of one volume of *n*-butanol and three volumes of ethyl ether. Flow through the column was aided by a positive pressure of about 26 cm of mercury. When 4 μg of malvidin chloride in 0.25 ml of the *n*-butanol-ether mixture was placed on the top of the column and washed through with the *n*-butanol-ether mixture, the pigment moved in a single, slowly widening band with an *R* value (*5*) of 0.35 ± 0.01. The pigment band was completely eluted by continued flow of solvent.

In a similar experiment with the same column, a solution of 4 μg of petunidin chloride in 0.25 ml of the *n*-butanol-ether mixture gave a single band which moved with an *R* value of 0.41 ± 0.01 and could be eluted completely. These *R* values have been duplicated. When a mixture of 2 μg of petunidin chloride and 2 μg of malvidin chloride in 0.25 ml of the *n*-butanol-ether mixture was placed in the same column, the single band which formed began to separate into two bands after moving about 2 cm. The *R* values of each of the two bands after complete separation were the same as the values determined with the single pigments. The first portions of the colored eluate were decolorized when shaken in air with 10% sodium hydroxide solution. Portions representing about the last fourth of the colored eluate when shaken with 10% sodium hydroxide solution showed a definite blue color which was stable in air for more than 5 min. Similar solutions made up from petunidin chloride showed identical color instability to 10% sodium hydroxide solution, while malvidin chloride solutions gave a blue color which was identical with that shown by the later eluates. Our conclusion is that the lower pigment band on our column is due to petunidin while the upper band is due to malvidin.

Further studies aimed at separation of larger amounts of mixtures of anthocyanidins are in progress.

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[1] The work reported here was done under contract between the Wine Advisory Board of the State of California and the University of Connecticut.

A Simple Double-Surface Dialyzing Membrane

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Very high concentration of botulinus toxin Type D can be obtained by growing the *Clostridium* in cellophane bags immersed in appropriate media (*1*). However, it is very difficult to tie the end of cellulose sausage casings securely enough to prevent bacteria growing through the tie. The difficulty can be overcome by pulling the end of the casing back through the tube. This forms a double-walled seamless tube. For our purpose saline is filled into the annular space between the walls and the whole tube is immersed in nutrient medium. The inoculum is placed in the saline.

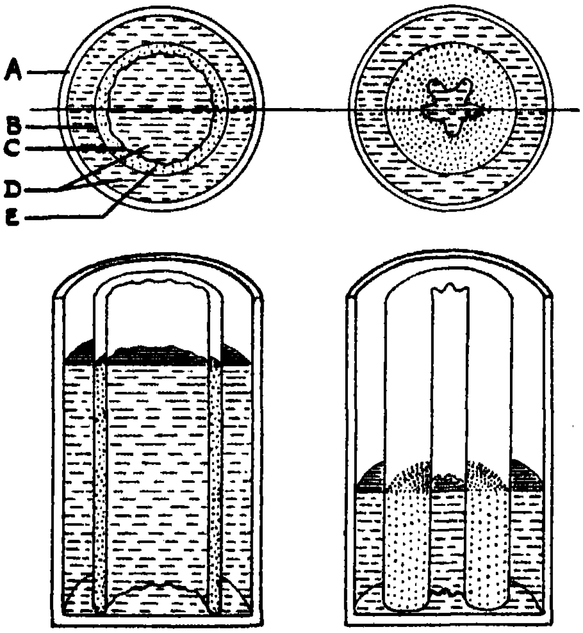

FIG. 1. At left, longitudinal and cross section of apparatus showing close approximation of cellophane walls when the level of outside liquids is high. At right, same cross section, but showing state when level of liquid outside cellophane walls is low. A—Container. B—Outside cellophane wall. C—Inside cellophane wall. D—Liquid outside cellophane container. E—Liquid inside cellophane container.

If the apparatus is required for dialysis, the liquid to be dialyzed is filled into the annular space between the cellophane walls. As the top is left open and as the membrane is flexible, the levels of the liquid inside and outside the membrane always remain the same. By varying the amounts of liquid inside and outside the bag, the dialyzing surface can be varied at will.

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Increased Radioresistance of Red Bone Marrow after Anoxia

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Jacobson *et al.* (*3*) have reported that the red bone marrow of rabbits, in which a regenerative anemia has been produced by phenylhydrazine hemolysis or by repeated bleeding, shows less histological injury following 800 r of total-body X radiation than does the normal. We have attempted to extend this to mice, using partial anoxia as the marrow stimulus.

One hundred and forty female mice (White Swiss Bagg, 18–20 gm) were randomly distributed into two groups. One was maintained at sea level pressure as control, and the other exposed to a simulated altitude of 15,000 ft (430 mm Hg) in an evacuated chamber for 10–14 hr a day. Both groups were kept at 25–30° C, and fed freely on standard chuck.

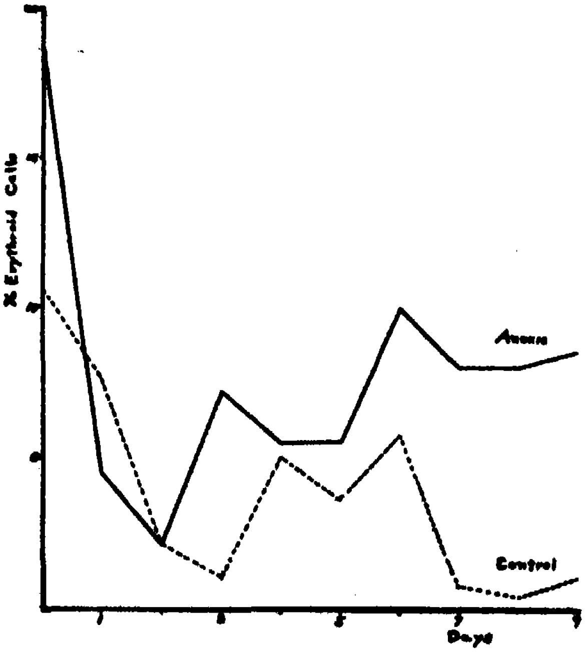

FIG. 1

Animals were sacrificed at intervals and the marrows examined as follows: Marrow from each femur was smeared and stained with Wright's stain. Late erythroblasts and normoblasts were counted together as erythroid cells and expressed as percentage of total marrow cells. Since early erythroblasts might be confused with myeloblasts and lymphocytes by the inexperienced observer, only the later forms of the red series were counted. Smears of marrow from each femur were counted by both observers independently. Each point in the figure represents the mean of 20 observations on five animals.

The percentage of erythroid cells in the marrow of this strain of mice was determined in 20 normal animals to be 10.6% ± 0.2%. Brecher *et al.* (*2*) found somewhat higher values, reporting total nucleated red cells.

The experimental group was maintained in the evacuated chamber until samples showed the erythroid cell level to have increased to 18.6% ± 1%. At this time both groups were exposed to 500 r of total-body X radiation and thereafter maintained at sea level pressure. The mice were placed 20 at a time in a paper box, 10 × 10 × 1.5 cm, and irradiated with a 200-kv machine filtered with 1 mm of aluminum and 0.5 mm of copper, and calibrated with a Victoreen r-meter.

The data are presented in Fig. 1.

The control group responded as would be expected from previous studies (*1*) and (*2*). There was a rapid fall in percentage of erythroid cells in the first two days, followed by a rise from the fourth to the sixth day. This apparent recovery coincided with the loss of myeloid elements, the percentage of erythroid cells falling off again as the myeloid series recovered.

The group which had been subjected to anoxia showed the same pattern to the sixth day. However, the sharp fall noted in days 6–9 in the control group was absent. The probability that the differences between groups on days 7, 8, and 9 were due to chance alone is 1/250. It therefore appears that the hyperplasia of the red marrow produced by exposure to low oxygen tension enhances the resistance of the erythroid elements of the mouse subsequently exposed to 500 r total-body X radiations.

References

1. Bloom, M. A. and Bloom, W. *J. Lab. clin. Med.*, 1947, **6**, 654.
2. Brecher, G. *et al.* *Blood*, 1948, **3**, 1259.
3. Jacobson, L. O. *et al.* *Science*, 1948, **107**, 248.

Comments and Communications

The System of Stable Nuclei

For some time it has been known that certain preferred numbers, N or $Z = 20$, 50, 82 or 126 give exceptional stability to a nucleus (Elsasser, W. *J. Physique Rad.*, 1933, 4, 549; 1934, 5, 389, 635; Mayer, M. G. *Phys. Rev.*, 1948, 74, 235). Just recently it has been pointed out that in the neighborhood of $Z = 82$ and of $N = 126$, nuclei with a number of protons or neutrons only approximately equal to these numbers have abnormally high binding energies, too (Way, K. *Phys. Rev.*, 1949, 75, 1448). The same conclusion had been reached independently by Mr. Wapstra of this laboratory in connection with his calculations of nuclear masses of natural radioactive elements (Rosenfeld, L. *Nuclear forces* I, Netherlands: North-Holland Pub.; New York: Interscience, 1948, pp. 525–529 and plate II).

As an example we shall give an approximative sketch of a series of isotopes of a single element with neutron numbers between 120 and 132. Nuclei with $N = 120$ and 121 will have roughly normal energy contents. The binding energy of the 122nd neutron is slightly enlarged, which brings the energy content of this nucleus somewhat below normal. The following neutrons are again added with binding energies larger than normal till the nucleus with the preferred number $N = 126$ has been reached. This is the isotope in which the energy content of the nucleus lies deepest below the normal level. The 127th neutron is bound with an exceptionally small energy effect, but the nucleus as a whole still has a lower energy content than it would have had under normal circumstances. It takes about four more neutrons, which are bound less tightly than the average, to bring the energy content of the nucleus back to normal, around $N = 132$. A diagram of the difference between the actual energy content of the nuclei and its interpolated normal value shows a horizontal line = 0 below about $N = 122$ and above about $N = 132$. Between these values a dip is observed with its lowest point at $N = 126$. It is difficult to say anything definite both about the actual width and about the shape of this dip, but it seems likely that it is steepest near $N = 126$ and flattens out on both sides.

Thus the stabilizing influence is not restricted to the exact preferred numbers but it is also active, though to a lesser extent, in nuclei containing a number of nucleons smaller or larger by a few units. These near-preferred numbers make a nucleus more stable than normal compared to ordinary nuclei but they decrease their stability towards nuclei containing a preferred or a nearer preferred number of nucleons. It can be demonstrated that a similar state of affairs occurs also in the neighborhood of other preferred numbers below $N = 126$ and $Z = 82$ and that it explains the majority of the apparent irregularities in the system of stable nuclei.

First it may be pointed out that, contrary to an occasional suggestion (Suess, H. E. *Zeitschrift für Naturforschung*, 1947, **2A**, 604), the excess binding energy is very nearly equal in a proton and in a neutron of the same preferred number. Proof of this fact is to be found in the perfectly regular series of half-lives of the $Z = N + 1$ nuclei and in the agreement of the positron energy limit of Sc^{41} with the value calculated from the liquid drop model (Rosenfeld, L. *Loc. cit.*, p. 383).

If the increased binding energy had occurred only in nuclei with "preferred numbers," only the stability of these nuclei and that of the adjoining odd-mass nuclei would have been affected. As it is, the extra stability of near-preferred numbers of nucleons is expressed in the nuclear energy diagram as additional local valleys superimposed on the main surface, which have an axis coinciding with a line indicating one of the preferred numbers. This means that the line of maximum stability shows exceptionally high values of dZ/dN at $N=50$ and $N=82$ and an abnormally low value at $Z=50$.

The course of the energy valley is seen easily from the $Z=f(N)$ representation of stable odd-mass nuclei. In this scheme, different nuclei with a constant neutron excess lie on diagonals, straight lines making an angle of 45° with both axes. Above $N=82$, from gadolinium onwards, the course of this line is very regular. It is almost unaffected by the preferred numbers $Z=82$ and $N=126$, as it passes very near their intersection. The average number of nuclei with constant neutron excess is somewhat less than 4, at lower masses it should be slightly higher. The actual number of nuclei varies to a certain extent (3,5,3,5,2,4,2. . . .) possibly due to irregularities of the energy levels in individual nuclei. The steepness of the $Z=f(N)$ curve in the region of $N=50$ is seen from the fact that here nine nuclei have the same neutron excess 11, whereas the preceding neutron excess is represented by five nuclei only, and the neutron excess 7 by three. It is equally satisfactory to find very short series at $Z=50$, two nuclei with neutron excess 17 and $2\frac{1}{2}$ nuclei with an excess of 19. (Members of isobar pairs of unknown stability are counted as $\frac{1}{2}$.) In the neighborhood of $N=82$ the situation is somewhat more complicated. It will be discussed presently, but here also the number of 11 nuclei occupying two adjoining diagonals is strikingly high. J. H. D. Jensen and H. E. Suess (*Naturwiss.*, 1947, 34, 131) have stressed the fact that apart from the elements missing in nature ($Z=43$ and $Z=61$), there are also two even elements, which do not have an odd-mass isotope (argon with $Z=18$ and cerium with $Z=58$). In these elements the reason is easily understood, as the odd-mass isotopes which would normally have been stable, have adjoining isobars, with energies lowered by $N=20$ and $N=82$. In argon, A^{37} decays to Cl^{37} and A^{39} to K^{39}. In cerium, the situation is analogous, Ce^{139} being unstable towards La^{139} and Ce^{141} towards Pr^{141}. (These transitions are included in Elsasser's and M. G. Mayer's considerations.) In the region of $N=82$, the nuclei with near-preferred numbers are stabilized sufficiently to cause a more extensive irregularity. Either La^{137} ($N=80$) or Pr^{143} ($N=84$) should normally have been stable, but because the stability is increased to a greater extent at $N=81$ or at $N=83$ than at $N=80$ or 84, the nucleus has decayed to an adjoining isobar with a nearer-preferred nucleon number.

The absence of the elements $Z=43$ and $Z=61$ is much more difficult to explain. The only point which can be made is that if elements are lacking in nature their nuclear charges 43 and 61 are among the values where this type of anomaly is not unlikely to occur. The choice is governed by three considerations. First, the energy valley should not be too narrow; therefore light masses are excluded. Then, dZ/dN should be as high as possible—we must be in a steep part of the curve. (Otherwise a heavier odd-mass nucleus will always have a strong tendency towards a higher neutron excess.) Finally, the anomaly should be near the transition point between two diagonals.

The system of stable nuclei of even mass can be fully described by the stability of the lightest and the heaviest isotope of each element, as all even isotopes between are stable too. The only exception, samarium, is easily explained by the theory of M. G. Mayer. Sm^{144} is stable because of its 82 neutrons, whereas Sm^{146} has not been found. It is probably β-stable, but it is almost certainly an α-emitter, decaying to Nd^{142}, because the α-energy is increased by the latter's number of 82 neutrons.

According to E. Feenberg (*Rev. mod. Phys.*, 1947, 19, 239) single even isobars are to be expected among masses >150. These are indeed observed at regular intervals in and above erbium, and also in and below germanium. Between these elements the only single isobars found—apart from Nd^{146}, which should have had Sm^{146} as its isobar—are Sr^{88} ($N=50$), Zr^{90} ($N=50$), Sn^{118} ($Z=50$), and Ce^{140} ($N=82$). These four are preferred-number nuclei, but this does not in itself provide an explanation of the absence of isobars. The real reason is that the adjoining odd-odd isobars have an increased binding energy too. This makes possible the decay, via this nearest-preferred nucleus, of the unstable even-mass isobar, in which the stability is increased to only a smaller extent. From the general course of the observed limits of β-stability one can easily see which isobars of the nuclei mentioned would have been stable if near-preferred nuclei had had normal energy contents: Zr^{88} (decays through Y^{88}), Sr^{90} (through Y^{90}), Te^{118} (through Sb^{118}), and Nd^{140} (through Pr^{140}) or Ba^{140} (through La^{140}). Ce^{144}, too, would have been a stable nucleus under normal conditions. As it is, Pr^{144}, with $N=85$, has an energy content sufficiently decreased to make possible the β-decay of Ce^{144}. The instability of the even isotopes mentioned explains why in these elements the odd-mass isotopes lie quite asymmetrically between the even ones. An additional reason is the shift of stability in odd-mass nuclei towards $N=82$.

Whereas the limits of β-stability are narrowed where a preferred number lies between them, they are widened in cases where the line indicating such a number runs near but outside one of the limits. In this case an extra even nucleus may be stabilized by the fact that it is nearer-preferred than the odd-odd nucleus through which it would have decayed under normal circumstances. This effect is seen in the triple isobars, of which four sets exist, at masses 96, 124, 130 and 136. Of these Sn^{124} ($Z=50$) and Xe^{136} ($N=82$) are stabilized by preferred numbers but Ru^{96} ($N=52$)—though it is difficult to say whether this nucleus is outside the normal β-stability limits or not—and Te^{130} ($Z=52$, $N=78$) owe their increased stability to near-preferred numbers. There can be little doubt that the exceptionally high abundances in ruthenium of the lightest isotopes—which are much rarer in other elements heavier than arsenic (Frank, F. C. *Proc. phys. Soc.*, 1948, 60, 211)—and in tellurium of the heaviest isotopes are due to the same stabilizing influence.

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α-Naphthaflavone as an Indicator in Iodometry

Many workers employ starch-test solution as the indicator of choice in iodometric titrations. The effectiveness of starch solution may depend upon the temperature, the amount of free iodide present, the presence of other salts and acids, the kind of starch used, and the method of preparation of the starch solution. Although the end reaction is usually accompanied by a blue color, or some shade thereof, the color obtained in iodine-starch combinations, depending upon the factors mentioned, may be at times violet or golden-yellow. Unless freshly prepared, starch solutions will decompose because of bacterial action; furthermore, the presence of suitable preservatives (Samuel, W. A. *Chem.-Anal.*, 1948, 37, 33) results in interference with color reactions in microdeterminations.

In studies on the use of minute quantities (ppm) of free iodine in water disinfection, we found that starch solution was not a suitable reagent and would not reveal the presence of free iodine in very small amounts.

When α-naphthaflavone, xanthones, quinones, and phthaleins are introduced into iodine solutions they usually produce blue-colored addition products. A search of the literature revealed that G. Barger and W. W. Starling (*J. chem. Soc. Trans. London*, 1915, 107, 411) first noted the production of a blue color with α-naphthaflavone and free iodine. This also was reported by H. Freundlich (*Physikal. chem. Grundlagen der Kolloidchemie.* Leipzig, 1924; English translation, Barger G. *The elements of colloidal chemistry.* New York: E. P. Dutton, 1924. P. 67), M. Hahn and co-workers (Hahn, M,. Schutz, F., and Pavlides, S. *Z. Hyg. Infekttionskr.*, 1929, 109, 530), and J. F. Reith (*Pharm. Weekblad*, 1929, 66, 1097).

Reith was the first worker to employ a 0.1% alcoholic solution of α-naphthaflavone as the reagent for titrimetric examinations and for the colorimetric analysis of free iodine solutions.

In our studies investigating the use of free iodine in water, especially in swimming pools, it was necessary to have available a very sensitive reagent or indicator to detect free iodine in amounts of less than 1 ppm. We found that a 0.1% alcoholic solution of α-naphthaflavone was stable and was more sensitive than starch-test solution in revealing minute quantities of free iodine. Concentrations as low as 0.1 ppm were readily detected, whereas starch reagent required at least 10 ppm of free iodine for the production of a sensitive color reaction.

In determinations where the free iodine concentrations were large (from 10 to 100 ppm), the color produced when using the α-naphthaflavone reagent varied from brown and brownish-blue to blue and violet. Quantities of free iodine less than 10 ppm revealed varying degrees of a blue, violet blue, and violet color.

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Erratum

In my communication "Toxicity and the Chemical Properties of Ions" in the August 19th issue of *Science*, the ionic field was printed as p^{1} (p. 194, second column, third line from bottom). It should be r^{1}, i.e. the reciprocal of the square of the ionic radius.

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University of Pennsylvania

Scientific Book Register

CRAIGIE, E. HORNE. *Bensley's practical anatomy of the rabbit.* (8th ed.) Philadelphia: Blakiston, 1948. Pp. xii + 391. (Illustrated.) $4.25.

DUKE-ELDER, STEWART. *The practice of refraction.* (5th ed.) St. Louis, Mo.: C. V. Mosby, 1949. Pp. xiv + 317. (Illustrated.) $6.25.

FIESER, LOUIS F., and FIESER, MARY. *Natural products related to phenanthrene.* (3rd ed.) New York: Reinhold, 1949. Pp. xii + 704. (Illustrated.) $10.00.

HEWITT, RICHARD M., *et al.* (Eds.) *Collected papers of the Mayo Clinic and the Mayo Foundation.* Philadelphia: W. B. Saunders, 1949. Pp. xii + 918. (Illustrated.) $11.00.

KLEIN, FELIX. *Geometry: elementary mathematics from an advanced standpoint* (Vol. II). (Trans. from 3rd German ed. by E. R. Hedrick and C. A. Noble.) New York: Dover Publ., 1949. Pp. ix + 214. $2.95.

ROBERTSON, B. L. and BLACK, L. J. *Electric circuits and machines.* New York: D. Van Nostrand, 1949. Pp. vii + 434. $5.00.

RUSHBROOKE, G. S. *Introduction to statistical mechanics.* New York: Oxford Univ. Press, 1949. Pp. xiii + 334. $5.50.

SCHNEIDER, WALTER A., and HAM, LLOYD B. *Experimental physics for colleges.* (Rev. ed.) New York: Macmillan, 1949. Pp. xii + 442. (Illustrated.). $3.80.

SIGGIA, SIDNEY. *Quantitative organic analysis via functional groups.* New York: John Wiley; London: Chapman and Hall, 1949. Pp. vii + 152. $3.00.

STAUFFER, ANDREW. (Ed.) *Introductory biology.* New York, Toronto, and London: D. Van Nostrand, 1949. Pp. ix + 722. (Illustrated.) $5.00.

STOUFFER, SAMUEL A., *et al.* *The American soldier: adjustment during army life.* (Vol. 1.) Princeton, New Jersey: Princeton Univ. Press, 1949. Pp. xii + 599. (Illustrated.) $7.50.

WARE, LAWRENCE A. and REED, HENRY R. *Communication circuits.* (3rd ed.) New York: John Wiley, 1949. Pp. x + 403. $5.00.

NEWS and Notes

The Rules Committee failed to place the **National Science Foundation bill (HR 4648)** on the House calendar before that body declared a recess until September 21, and it has been learned from reliable sources that no action of any kind will be taken until the House reconvenes. Scientists may profitably utilize this period to interview their representatives, many of whom will be at home. Most vigorous opposition to the bill has come from Representative James W. Wadsworth (41st District, New York) who has announced to the press that the Rules Committee will take no action on the bill this session, notwithstanding the fact that it has been proposed to limit appropriations for the Foundation to the modest sum required for organization and administration during the first year of its existence. This proposal has been accepted by J. Percy Priest, author of HR 4648 and, it is reported, by the President. Under the circumstances it is difficult for Representatives Wadsworth, Herter (Massachusetts), and Sabath (Illinois) to justify their opposition to the Foundation on the grounds of economy, but no other reason has been given.

Congressional action on the medical sciences during the week of August 22, as summarised by *Washington Report on the Medical Sciences*, included a favorable report by the House Interstate and Foreign Commerce Committee on HR 5903, the hospital construction aid bill, which is substantially the same as S614, passed by the Senate on August 9. The House also passed HR 6022, which authorizes liberal salary increases for physicans, dentists, and nurses in the Veterans Administration Medical Department. The Murray Subcommittee of the Senate on health legislation approved a completely revised S1651, which would add two new research institutes to the federal establishment—one on rheumatic and metabolic diseases and another on neurological diseases and blindness. The Murray Subcommittee is also considering S2211, directing the Public Health Service to conduct a sampling survey of chronic and degenerative illness.

About People

Ingvar Svennilson, head of the Swedish Institute for Industrial Research, will direct a two-year study of changes during the past forty years in European economy in order to determine to what extent it has been affected by government interference in trade between nations. The United Nations will publish the reports of the investigation, which will be financed by the Rockefeller Foundation. Dr. Svennilson's headquarters will be in Geneva, Switzerland.

Nicholas Stefan Halmi, former member of the Anatomical Institute of the University of Sciences at Pecs, Hungary, has arrived here on a nonquota visa issued by the United States Consulate General at Munich. Dr. Halmi will join the faculty of the University of Chicago as instructor of anatomy.

Robert A. Harte, secretary of the Amino Acids Advisory Committee of the United States Pharmacopoeia, has been appointed research administrator of the Medical Research Division, Sharp and Dohme, Inc., Philadelphia. Mr. Harte did work in immunochemistry with the Rockefeller Institute of Medical Research, New York City, from 1932 to 1942.

William Hovanitz has resigned his position at Wayne University to become professor of biology at the University of San Francisco. Dr. Hovanitz will give courses in genetics and biometry.

Frederick P. Thieme, who has recently been engaged in an anthropological survey in Puerto Rico, has been appointed instructor in physical anthropology at the University of Michigan.

Siegfried Woislawski, of the University of Rochester Medical School, has been appointed research instructor in the Cancer Research Laboratory of the University of Florida.

Lester J. Evans, medical associate of the Commonwealth Fund, has been appointed consultant in medical education to the State University of New York, New York City. Dr. Evans will assist the trustees of the university in formulating the medical education program.

Hans Ris, associate in zoology at the Rockefeller Institute, has been appointed professor of zoology at the University of Wisconsin. Dr. Ris, a native of Switzerland, was graduated from the University of Bern.

Visitors to U. S.

An international medical commission is making a six-week tour of venereal disease clinics in this country for the World Health Organization. The group includes **Sidney Laird**, adviser in venereology at Suffolk, England; **E. I. Grin**, director of the government venereal dispensary in Sarajevo, Yugoslavia; **Juan M. Funes**, director of the rapid treatment center at Guatemala City; **N. Jungalwalla**, venereal disease adviser to the government of India; **Poul V. Marcussen**, director of the municipal venereal disease clinic at Copenhagen, Denmark; and **Pierre Joulia**, professor of dermatology and syphilology at Bordeaux University, France.

José M. Cruxent, director of the Museum of Natural Sciences, Caracas, Venezuela, has been conferring with officials of the Smithsonian Institution and other museums throughout the country.

Visitors at the National Bureau of Standards during the week of August 22 included **R. Yarar**, assistant professor at the Technical University of Istanbul, Turkey, and **H. W. Thompson**, professor of chemistry, Oxford University, England.

Custodia Fuenzalida, supervisor of student nurses and instructor of pediatric and surgical nursing in the children's hospital and maternity ward of the University of Chile, is here on a public Health Service training grant. Miss Fuensalida will study at the School of Nursing of the Boston University.

Grants and Awards

The University of Michigan has announced the award of research grants to faculty members amounting to $105,906. Of this sum, $87,413.50 is in grants made by the Board of Governors of the School of Graduate Studies from the Horace H. Rackham Fund, including $25,000 for fellowships and $8,000 for the publication fund. The six largest specific research grants also were made from this fund.

The University Observatory was alloted $7,260 to continue spectroscopic studies of the southern sky at the University's South African observatory. A grant of $6,000 was made for research projects being planned by the Center for Japanese Studies. Other projects include studies of the behavior of the endocrine glands and the existence of behavior problems in children, the functional breathing capacity of the lung, the growth and regeneration of endosperms in culture, and the Pleistocene history of the Great Lakes.

G. E. F. Lundell, former chief of the Chemistry Division of the National Bureau of Standards, will receive the **$1,000 Fisher Award in Analytical Chemistry** at the 116th national meeting of the American Chemical Society in Atlantic City on September 19. Dr. Lundell, who retired from the Bureau of Standards last year, was cited for his contribution to applied inorganic analysis and for his ability to train young men in the field of analytical chemistry. The award was established in 1947 by C. G. Fisher, president of the Fisher Scientific Company of Pittsburgh, to recognize and encourage outstanding achievement in the science of analytical chemistry. It was conferred for the first time last year on Dr. N. Howell Furman of Princeton University.

The Royal Society of Tropical Medicine and Hygiene of London has elected William H. Taliaferro, chairman of the Department of Bacteriology and Parasitology at the University of Chicago, an honorary fellow. Dr. Taliaferro holds the Eliakim Hastings Moore distinguished service professorship of parasitology at the university.

The Ross Coffin Purdy Award of the American Ceramic Society was granted to Herbert Insley, chief of the Mineral Products Division of the National Bureau of Standards, and F. P. Hall, assistant director of research at the Onandaga Pottery Company—joint authors of *Phase Diagrams for Ceramists*.

The Honor Scroll of the American Institute of Chemists will be presented on October 7 to Otto Eisenschiml, president of the Scientific Oil Compounding Company. Dr. Eisenschiml will deliver his acceptance address on "The Responsibility of the Community to Its Chemists."

The Navy Bureau of Ordnance has granted a two-year research contract to Eugene Lieber, associate professor of chemistry at Illinois Institute of Technology. Dr. Lieber will conduct research in the new derivatives and chemical and physical properties of nitroguanidine.

The Frederick Ives Medal of the Optical Society of America will be awarded to George R. Harrison, dean of science at Massachusetts Institute of Technology. Dr. Harrison will receive the award at the annual meeting of the society at Buffalo in October for his contribution to the field of optics.

The Croix d'Officier du Merite Agricole has been given to William V. Cruess, professor of food technology at the University of California College of Agriculture. The honor was conferred by the French Consul General Jean de Lagarde.

Colleges and Universities

Washington University, St. Louis, will begin construction of a $900,000 building for research in the basic sciences related to cancer. This laboratory is the third announced addition to the Washington University Medical Center. Half the funds for the new research center were contributed by the U. S. Public Health Service, the other half by the university.

Research on cosmic rays is being carried on in the Rocky Mountains in Colorado by scientists from the **University of Washington Applied Physics Laboratory.** By means of a dual cloud chamber apparatus equipped with built-in cameras, the vapor trails of cosmic rays will be recorded as they pass through vapor compartments at an elevation of more than 11,000 feet. The project which is sponsored jointly by the Office of Naval Research and the university is under the supervision of Joseph E. Henderson, director of the laboratory. Charles E. Miller, assistant director, will head the expedition.

Roosevelt College, Chicago, will conduct a ten-week institute, "New Frontiers of Science and Industry," September 21–November 23. The list of speakers and their subjects are: Percy Julian, director of research, Glidden Company, "New Horizons in Science," September 21; G. P. Kuiper, director of Yerkes Observatory, "New Results on the Planets," September 28; Gustav Egloff, director of research, Universal Oil Products Co., "Have We Enough Petroleum?," October 5; E. M. K. Geiling, Pharmacology Department, University of Chicago, "What's New in Drugs?," October 12; Samuel K. Allison, director, Institute for Nuclear Studies, University of Chicago, "New Energy from Atoms," October 19; Jules Masserman, Medical School, Northwestern University, "What is Modern Psychiatry Doing?," October 26; Anton J. Carlson, Department of Physiology, University of Chicago, "Your Body and You," November 2; Andrew C. Ivy, vice president, University of Illinois, "What's New in Medicine?," November 9; Louis N. Ridenour, Graduate College, University of Illinois, "Machines that Think," November 16; and Cyril Stanley Smith, Institute for the Study of Metals, University of Chicago, "Metals and Your Life," November 23.

The sessions will meet on Wednesday evenings at 8 p.m; admission will be $5.00 for the entire series and 75 cents for individual sessions.

Meetings and Elections

The National Science Teachers Association will hold a regional meeting at the Mellon Institute in Pittsburgh on September 30. Thomas Parran, dean of the Graduate School of Public Health, University of Pittsburgh, will be the main speaker at the luncheon session. Work sessions will include the evaluation of business-sponsored teaching aids for science. More than one hundred industries in the Pittsburgh area, eastern Ohio, and northern West Virginia have been invited to participate. Additional information may be obtained from Robert H. Carleton, Executive Secretary, National Science Teachers Association, 1201 Sixteenth Street, Northwest, Washington 6, D. C.

The American Oil Chemists' Society will hold its fall meeting at the Edgewater Beach Hotel, Chicago, October 31–November 2 with advance registration on the 30th. C. E. Morris, of Armour and Company, will serve as general chairman of the meeting, and R. H. Rogers, Jr., of Swift and Company, as exhibits chairman.

The Pacific Chemical Exposition and the Pacific Industrial Conferences, under the sponsorship of the American Chemical Society, will be held in San Francisco, November 1–5. There will be more than a hundred commercial exhibits, a group of special exhibits, continuous motion pictures, and fourteen one- and two-day conferences.

The Society for Applied Spectroscopy will meet Tuesday, November 1, at 8 p.m. at the Socony-Vacuum Training Center, 63 Park Row, New York City. William L. Dutton of the American Cyanamid Company will speak on semiquantitative analysis for metals by emission spectroscopy.

A National Symposium on Air Pollution, presented by Stanford Research Institute in cooperation with the California Institute of Technology, the University of California, and the University of Southern California, will be held November 10 and 11 at the Huntington Hotel, in Pasadena, California.

The annual national meeting of **the American Institute of Chemical Engineers** will be held in Pittsburgh, December 4–7, with headquarters at the William Penn Hotel. Technical symposia will include panel discussions on the present status of professional legislation, corporation training of young engineers, industrial waste disposal, atomic energy, and vapor-liquid equilibria.

The Academy of Forensic Sciences (American Medico Legal Congress) will hold its second meeting in Lincoln Hall, Northwestern University School of Law, Chicago, on January 26–28, 1950. The meeting will be devoted to a discussion of forensic science problems and a formal organizational program. Persons interested in presenting papers should contact Dr. A. W. Freireich, 180 Hempstead Avenue, Malverne, New York, or Professor Ralph F. Turner, Acting Secretary, Department of Police Administration, Michigan State College, East Lansing.

The National Society for the Prevention of Blindness will hold a five-day conference in conjunction with the interim session of the Pan American Association of Ophthalmology, March 26–30, 1950, at the Floridian Hotel, Miami Beach, Florida. The theme of the meeting will be "The Americas Unite to Save Sight." Among the subjects to be discussed are current blindness-prevention programs in countries of the Western Hemisphere, trachoma, industrial ophthalmology, eye problems of school children, and medical and social management of the glaucomas.

Persons concerned with eye health and safety may obtain details concerning the program by writing to the National Society for the Prevention of Blindness, 1790 Broadway, New York 19, N. Y. Reservations should be made in the near future with the Floridian Hotel, 540 West Avenue, Miami Beach, Florida.

The American Pharmaceutical Association has elected the following officers for the coming year: president, Henry H. Gregg, pharmacist, Minneapolis, Minnesota; first vice president, Roy A. Bowers, dean, University of New Mexico College of Pharmacy, Albuquerque, New Mexico; and second vice president, Louis J. Fischl, pharmacist, Oakland, California.

The newly-organized **Central States Section of the Botanical Society of America**, at its meeting at Ann Arbor, Michigan, August 20, elected the following officers: chairman, John E. Sass, of Iowa State College; vice chairman, Margaret H. Fulford, of the University of Cincinnati; members of the executive committee, Paul Weatherwax, of the University of Indiana, Howard W. Larsh, of the University of Oklahoma, and G. W. Prescott, of Michigan State College. Oswald Tippo, of the University of Illinois, was re-elected as secretary-treasurer.

Deaths

Edwin C. Miller, 70, professor emeritus of plant physiology at Kansas State College, Manhattan, Kansas, died August 2 of cerebral thrombosis. Dr. Miller was formerly a plant physiologist at the Kansas Agricultural Experiment Station, and was at one time president of the American Society of Plant Physiologists.

Eugene Waldemar Posnjak, 61, Russian-born geochemist, died at his home in Santa Barbara, California on August 5. Dr. Posnjak retired from the Geophysical Laboratory of the Carnegie Institution, Washington, D. C., two years ago, after 34 years of service.

Arthur Cloudman, 48, senior biologist at the Argonne National Laboratory, died at his home August 8. Dr. Cloudman was conducting experiments on radiation as a possible cause of cancerous growth.

Bruce H. Douglas, 56, health commissioner of Detroit, was killed August 11 in an automobile accident. Dr. Douglas was formerly professor and head of the Department of Preventive Medicine and Public Health at Wayne University, and past president of both the Mississippi Valley Tuberculosis Conference and the National Tuberculosis Association.

Rudolph Luneburg, 46, mathematical physicist at the University of Southern California, died August 19 of a heart attack. While a member of the mathematical research staff of the Spencer Lens Company of Buffalo, Dr. Luneburg contributed to the development of a new method of viewing microscopically the internal structures of living cells, tissues, bacteria, and industrial material.

A new journal, ***Experimental Cell Research***, is being sponsored by the International Society for Cell Biology. The editors are Törbjorn Caspersson, Stockholm; Honor Fell, Cambridge, England; John Runnström, Stockholm; Francis O. Schmitt, Cambridge, Massachusetts; Paul Weiss, Chicago; and Ralph W. C. Wyckoff, Bethesda, Maryland. J. F. Danielli, of London, will act as editor of communications from the Society for Cell Biology. Papers contributed by American scientists should be sent to the American editors. One volume of four issues will be published annually by the Academic Press, Inc., and will include studies in experimental analysis of the organization, structure, and activity of the cell and its sub-units, including work on viruses, and on new methods in the field of experimental cytology.

The Atomic Energy Commission has awarded a contract to Holmes and Narver, Engineers, Los Angeles, California, for maintenance and improvement of facilities at the Atomic Energy Commission Proving Ground at Eniwetok Atoll in the Marshall Islands. Repairs, replacements of certain structures and utilities rendered useless by the tropical climate, and the installation of more durable technical facilities are planned.

Suggestions for Science Teachers in Devastated Countries, a Unesco publication which describes how school laboratory equipment can be constructed out of simple, inexpensive materials has been translated into Tai by the government of Thailand. This is one phase of a Unesco program begun in January when Thailand joined the organization. A survey of the country has already been completed by a Unesco educational mission.

The membership of the **Panel on the Nation's Potential for Basic Research in Chemistry**, National Research Council, for the year ending June 30, 1950, is as follows: G. B. Butler, L. W. Butz, W. C. Johnson, W. R. Kirner, W. M. Latimer, W. A Mosher, W. J. Murphy, W. A. Noes, Jr., ex officio, L. H. Reyerson, C. E. Waring, *chairman*, G. W. Watt.

The panel has surveyed unemployed capacity during the last two years. Chemists have submitted the titles of over 200 research projects which they could carry out if some financial assistance were provided. This year the panel plans to survey the equipment needs of colleges and universities, to maintain liaison with agencies concerned with national research programs, and to publish its findings more widely.

Recently Received—

Statistical Summary of Education, 1945–46, by David T. Blose. (Biennial survey of education in the U. S., 1944–46, Chapter 1, Federal Security Agency.) For sale by Supt. of Documents, U. S. Govt. Printing Office, Washington 25, D. C. 15 cents.

Freedom from Want: A Survey of the Possibilities of Meeting the World's Food Needs. (Symposium edited by E. E. DeTurk for the AAAS and reprinted from Chronica Botanica.) Order from Chronica Botanica Co., Waltham, Mass., or Stechert-Hafner, Inc., New York City. $2.00.

Anais Brasileiros de Dermatologia e Sifilografia. Publiçacao trimestral by Sociedade Brasileira de Dermatologia e Sifilografia, Rio de Janeiro, Brasil.

The Medical Bulletin (Medicine for Industry). Publication of the Standard Oil Company of New Jersey, New York 20, N. Y.

La Recherche Aéronautique. (Bulletin bimestriel de l'Office National d'Études et de Recherches Aeronautiques). O.N.E.R.A. 3, Rue Léon Bonnat, Paris 16^e, France.

The George C. Davis Site, Cherokee County, Texas by H. Perry Newell and Alex D. Krieger. (Memoirs of the Society for American Archaeology, No. 5). Order from Glenn A. Black, Treasurer, Angel Mounds, R. R. 3, Newburgh, Ind. $3.50.

Eine Methode zur approximativen Vorausberechnung von Luftmassenverlagerungen by Hans Ertel. (Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Jahrgang 1948 Nr. III). Akademie-Verlag, NW7, Berlin, Germany. 2 marks.

Journal of the Mathematical Society of Japan. (Continuation of mathematical section of Physico-Mathematical Society of Japan.) Single copies available from Mathematical Society, Faculty of Science, Toyko University, Japan. 150 yen.

Air Transport and Insects of Agricultural Importance, by W. A. L. David. Commonwealth Institute of Entomology, London, S. W. 7, England. 1s. 6d. postpaid.

Scandinavian Journal of Clinical and Laboratory Investigation, Vol. 1, No. 1, 1949. (New Quarterly publication in English edited for Scandinavian Society for Clinical Chemistry and Clinical Physiology.) Published by Medical Department, Medisinsk Fysiologisk Forenings Forlag, Oslo, Norway. Subscription price N. kr. 35.00.

Ruth Fulton Benedict, A Memorial. Issued by Viking Fund, Inc., New York, N. Y.

Make Plans for—

American Society for Metals, symposium on thermodynamics in physical metallurgy, October 15–16; **31st National Metal Congress and Exposition**, October 17–21, Public Auditorium, Cleveland, Ohio.

American Institute of Electrical Engineers, Midwest general meeting. October 17–21, Netherland Plaza Hotel, Cincinnati, Ohio.

Temperature Dominance over Human Life

Clarence A. Mills

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TEMPERATURE bears an importance to man far beyond the mere matter of his hour-to-hour comfort. In some places it lays a heavy, stagnating hand over his life and holds him to a vegetative existence; in others, it generates an energy and progressiveness which drives him forward with irresistible impetus. Its effects begin even before he is conceived, for the metabolic vigor of parental germ cells at the time of their union exerts a potent influence over the entire course of the new life. Without favorable temperatures, neither individual nor nation can develop innate potentialities to the full.

The hand of temperature is being felt over the world today, much as Ellsworth Huntington so ably pictured its course through past centuries. We are now caught in one of the long cycles of climatic change that alter the courses of nations and of world trends. Man thus has urgent need to understand the mechanism of this temperature dominance over him as an individual and over mankind as a whole. The answer lies in a close study of human dynamics.

The human body is essentially a combustion machine that functions only as its cells release energy by burning the foodstuffs taken in. True, this combustion in the cells is a very complicated affair, carried on at low temperatures and in numerous independent steps through the aid of special catalysts. Although it is far less violent than the gasoline explosions in an automobile motor, its over-all efficiency is no greater, and it is even more dependent upon rapid dissipation of its waste heat. The working efficiency of men, horses, and dogs ranges between 20 and 25 percent, but the Diesel engine designed by present-day engineers performs at over 40 percent efficiency.

For every unit of combustion energy transformed into work-output by our bodies, three or four similar units must be dissipated as waste heat. Failure of such dissipation to keep pace with heat production in the body may mean heat stroke and death within a few hours. The waste heat of combustion thus becomes one of the body's most important excretory products.

Sudden changes in external temperatures, or in the rate of heat production within the body, are quickly countered by the movement of more blood into, or away from, the skin and by the activity of the sweat glands. The body can thus meet short-term emergencies with only slight changes in its internal temperature or behavior characteristics. External heat or cold, prolonged through many weeks or months, however, induces basic and important changes in the body economy.

Following several weeks of difficulty in dissipating waste heat, physical and mental activity declines, and there is is a drop in the combustion rate. Some of the glands of internal secretion, which so largely influence combustion rate, go into a less active, or resting, state. This is particularly true with the thyroid, adrenal, and sex glands, probably also with the pituitary. A lowered total combustion rate means less energy for thought and action, as well as less waste heat to be dissipated. Physical and mental characteristics thus change, from the dynamic and pushing, to a more passive, "let-George-do-it" type. Personal initiative gives way to a desire for security.

That these are basic changes in the individual's metabolic make-up is evidenced by equally profound alterations in such body functions as growth, rate of development, resistance to infection, and thought capacity. When difficult heat-loss induces a lowered combustion rate in the cells, growth slows down and may be completely halted, even though an ample food supply be available; onset of puberty and maturity is progressively delayed, and ability to reproduce is reduced or completely obliterated, although matings go on freely; resistance to bacterial invasion is impaired, especially for those respiratory infections in which the white blood cells (phagocytes) provide the first and main line of the body's defense-system; and, finally, ability to solve problems is greatly impaired.

Proper ease of body heat-loss means just the opposite—a fast growing, early maturing, highly fertile individual, with a keen mentality and good ability to fight infectious disease. These statements are by no means hypothetical but are based upon well authenticated statistical findings on man and on experimental animals under controlled conditions. They show up in the laboratory, under natural climatic differences, and during the wide seasonal swings in middle temperate latitudes.

Half of the earth's population lives year after year under a depressive blanket of moist heat that makes impossible an active life or high vitality. There children grow slowly, mature late, and are, in the main, of inferior stature. Although the birth rate is high because of lack of restraint, high stillbirth and infant mortality rates cut heavily into the ranks of those who might live on to adulthood. Infectious diseases are the chief causes of death at all ages. The menses come on 1½–2 years later than among girls of cooler climates, and reproductive fertility shows an even greater lag. The age-old fallacy of early tropical maturity should be abandoned—it probably represents a carry-over from the Ice Age of 20,000 years ago, when optimal temperatures for man were to be found only in what are now the tropical regions. Even two millenniums ago, Hippocrates was stressing the fallacy of early tropical maturity, although the girls of ancient Greece were beginning their menses at the same early age as in middle American latitudes today. With the subsequent rise in earth temperatures, the girls of Greece today begin their menses two years later than in Hippocrates' day.

Domestic livestock show a comparable retardation where heat-loss is difficult. To bring a steer to the choice 1000-pound slaughter-size takes 12–15 months in Iowa or Illinois, 2½–3 years in Louisiana, and 4–5 years in Cuba, Panama, or Colombia. This represents maximum adult size in the tropical heat, whereas in Iowa or Illinois the steer will grow to almost double this weight. Hogs show the same contrast, taking 15 months in Panama to reach the 200-pound slaughter size achieved by Iowa shoats in 6–7 months.

In spite of the lack of sexual restraint and our "Mother India" ideas of early tropical maturity, evidence indicates that functional fertility is attained several years later, on the average, among tropical girls than among the more lusty progeny of cooler climates. Laboratory findings under controlled temperature conditions provide complete confirmation of the human statistics. Difficulty in heat-loss can so reduce animal fertility that conceptions become impossible, even with oft-repeated matings. Human conceptions resulting in live births are also sharply reduced during prolonged periods of severe heat among people of the temperate regions. The whole state of Florida suffers a 30 ± percent decline in conceptions during the long summer heat, whereas in Maine conception rates then are highest.

The body's ability to resist or survive infectious attacks goes down with all other vital indices in tropical heat or in long subtropical summers. The number of deaths per 100 acute appendicitis cases hospitalized in the Gulf states is twice as high as in the Upper Plains states; and at Cincinnati, migrants from the South last just half as long with tuberculosis as do the Northern-born, considering only those who die, from first symptoms to death. Those adapted to heat also succumb more readily to pneumonia—a Dakota winter would produce a holocaust of pneumonia deaths in Panama or the Philippines!

Loss of mental acuity constitutes perhaps the most disturbing phase of heat effects, when viewed from the standpoint of the general welfare of mankind. Some years ago Ellsworth Huntington collected statistics showing best mental function at 38–40° F, whereas 64° F seemed optimal for physical performance. Today we know that college students, given the standard aptitude or intelligence tests at Cincinnati latitudes across the country, achieve ratings only 60 percent as high in summer heat as in winter cold. No such seasonal contrast in ratings occurs in the northern tier of states, where there is no prolonged depressive summer heat.

White rats have further confirmed the folly of summer sessions in colleges at lower latitudes unless the students be air-conditioned. With three groups of male rats from divided litters, kept on uniform diet and at three different environmental temperatures, it was found that ability to solve maze-tests was sharply retarded with increasing difficulty of heat-loss. The rats kept for four months at 55° F required only 12 trials before finding the correct maze pathway to the food dish; and, once they found the proper turns, no further errors were made on later testings. Those kept at 75° F made, on the average, 28 wrong turns before discovering the proper pathway, and even then their learning was far from complete. For the rats kept at 90° F, food seemed not worth the effort; those that did get through to the food took an average of 51 wrong turns and still could not repeat on successive days.

The rats' memory, or retention of learning, was tested by bringing them back to the maze after a month's absence. Those from the 55° F room showed perfect retention of their previous learning, those from the 75° F warmth had to relearn about half, but those from the 90° F heat seemed to retain no memory of their former efforts.

These basic observations on temperature dominance over mental ability and physical development are indeed of great significance to mankind as it faces existence problems in many regions of the earth. Should the more favored portions of our country give aid to those peoples whose living conditions are more adverse? Should such aid take the form of educational funds or of nutritional upbuilding? Fortunately, nutritional studies on animals have demonstrated that most of the depressive heat effects can be overcome by proper attention to vitamin and protein intake. Certain of the B vitamins are needed in extra amounts, and hot-weather diets should be richer—not poorer—in protein, if we would avoid metabolic letdown. Actually, our protein requirement remains the same (in grams per pound of body weight) in heat and cold, but a lowered caloric intake in hot weather makes it necessary that the smaller amount of food eaten be richer in protein.

Difficulty in body heat-loss begins its dominance over any person's life even before he is conceived. The metabolic vigor of parental germ cells at the time of their union exerts a considerable influence over the whole life course of the new individual. Those children at Cincinnati latitudes whose parents have been depressed by July and August heat before conception have just half the likelihood of entering college that is enjoyed by those conceived in winter cold. Those conceived in summer heat also grow more slowly, develop later, and live a shorter life span (over four years less, according to Huntington's findings).

Further handicaps of hot-weather conception include a low likelihood of inclusion in *Who's Who* volumes and of being president of the United States of America. Eleven of our presidents were conceived in the first quarter of the year, ten in the second, *four* in the third, and seven in the fourth. Until the present incumbent entered the White House, there had never been an August conception at the head of our government. In any field of accomplishment one investigates, the advantages of cold-weather conception stand forth in bold relief. Perhaps these facts will find expression in high school or college eugenics courses and in planned parenthood through coming years. If so, the country's obstetricians will be able to plan a long vacation for each year!

Climatic temperature differences, whether brought about by latitude or altitude, are potent factors in human life, and so also are the wide seasonal temperature swings of the earth's middle latitudes. The fortunate nations of the earth are those located where the body's waste heat can be lost readily. Many other factors of life are also of great importance, of course, but this article is devoted to the basic role of temperature. Due recognition must be given to the part that improved nutrition may play in minimizing the depressive effects of external heat. Natural resources may thus exert a marked and beneficial effect on a given population group by making possible a better dietary intake, but dietary improvement will still be conditioned on the exercise of mass intelligence in food selection and on the willingness to work for the better food, no matter how great the natural resources. We thus come back to energy as the mainspring of life, with all its potentialities and handicaps.

Proper ease of body heat-loss may be essential to progressiveness and accomplishment, but its advantages are by no means free of hazards. Evidences of mental and physical breakdown are today most alarming in those regions of the earth where temperatures are most energizing. Arteriosclerosis and heart failure, diabetes, cancer, and many other breakdown diseases are there claiming far more victims than in tropical warmth, where infectious diseases run rampant. Northern rates of mental instability and breakdown, for instance, more than offset the decrease in tuberculosis deaths. Perhaps some day artificial conditioning will provide us with the Golden Mean.

Up through the millenniums since the last Ice Age, the crest of human civilization has shifted farther and farther poleward, with irregularly rising earth temperatures and melting ice caps. Improved housing and greater protection against winter cold have been considerable factors in this poleward shift, but probably of greater importance has been the expanding region of tropical heat. Volumes of argument pro and con would add little to that statement about the distant past, so let us move to more recent times.

Through the last 10,000 years of the earth's history, cyclic changes in temperatures have left fairly clear records. A millennium of rapidly receding glaciers and polar ice caps was succeeded by one of stability or advance. Five such cycles are in evidence over the last 10,000 years of rapid Ice Age regression. The next-to-last cold millennium fell in the days of early Greek and Roman glory and was followed by the thousand years of Dark Age warmth, when cereal grains could be ripened in Iceland and grapes in England.

The peak of Dark Age warmth occurred about A.D. 850, when optimal temperatures in far northern Scandinavia activated the Norsemen and Vikings into a century of exploration and settlement. The gradual return of benumbing cold to their homeland and to the Greenland and Iceland settlements from the tenth to the fourteenth centuries dimmed their glory. Central Europe was at the same time relieved of her enervating warmth and entered the Renaissance and the period of industrialization. The miracles of this Western mechanistic civilization have reached a peak in America during the century just passed.

Once again earth temperatures are surging irregularly upward, reaching levels in 1930 about as high as prevailed a thousand years earlier. During the warmth of the early thirties soil thawing in Greenland allowed excavation of Viking bodies that had lain in solidly frozen earth for a thousand years. All records available indicate that earth temperatures have been rising for a full century, bringing definitely milder winters and the long summers of depressive heat that sap human energy and change the course of nations.

The same semitropical lethargy which earlier engulfed the Mediterranean countries of Europe is today creeping northward over the United States and Central Europe. Later onset of the menses in girls and smaller adult stature in American college youth have replaced the trend of recent centuries toward earlier maturity and ever-better physique. In the Carolinas the reversal came with children born in 1918, at Cincinnati latitudes a little later, and in Wisconsin it still remains only an indefinite hint. It is especially significant that this physical downturn should have occurred at a time when the production and distribution of foodstuffs were at all-time peaks and when greatest emphasis was being laid on child care and nutrition. Children now have fewer illnesses and grow faster in their early years than ever before; yet the adult stature is showing definite evidence of decline.

The northward shift of world power was emphasized by Germany's bid for a "place-in-the-sun" in World War I. Only the superior ingenuity and resources of Britain and America kept her from her goal, for Russia was then only in the early throes of her awakening, and France was quite incapable of coping with her more vigorous neighbor. When World War II came a quarter-century later, America was pushed to new peaks of industrial productivity and scientific advances that contributed substantially to victory, but the war's most significant outcome was the bid for world power by a new far-northern nation—Russia.

Retarded by the benumbing winter cold of past centuries, much of Russia today enjoys temperatures which are near the optimal for human endeavor. Freer flow of her energies and the heady successes of war and postwar years have given her a self-confidence that considers nothing impossible. Hers is now the early American frontier reaction of bubbling enthusiasm and nigh irresistible impetuosity. In the warm centuries ahead she may gain the sought-for place-in-the-sun, along with the lesser northern nations of Scandinavia and Canada. To appreciate that Russia is really a far-northern nation, one should bear in mind that the city of Stalingrad lies close to the latitude of Winnipeg.

The effects of temperature will go far beyond their present influence over individual life and national trends. The present millennium of warmth may witness complete melting of the polar ice caps and consequent profound changes in the climates of present polar and temperate zones. The earth has experienced long eons of freedom from polar cold during past periods of interglacial warmth, and Brooks, in his book, *Climate through the ages*, pictures the present ice caps as being down to the critically small diameter that makes them susceptible to rapid disappearance. Anyone desiring to make use of this information for long-term investment in northern real estate should buy high land, however, for the ocean level will rise roughly 150 feet as the ice caps disappear.

Present-day international interest in the mineral and fuel deposits of Antarctica may prove to be well based, in view of these temperature trends. Also, the broad, fertile, but still frozen reaches of northern Siberia and Canada may someday support the earth's most energetic populations, if the present outward expansion of semitropical lethargy continues. It takes only a few degrees of change in mean annual temperature to produce striking climatic alterations. Dark Age temperatures of Scandinavia, Britain, Iceland, and Greenland, for instance, were probably only 4–5 degrees higher than those prevailing through the colder centuries since the time of the Renaissance.

Much study and speculation have centered around the possible causes of these shifts in earth temperatures. The regular seasonal cycles are, of course, known to be based upon the changing inclination of the earth's axis with respect to the sun. Variations in sunspot activity and in the intensity of solar radiation to the earth have also been correlated with periods of unseasonal cold or warmth. Sudden outbursts of sunspot activity are accompanied by increased heat and magnetic radiation to the earth but are soon followed by greater storminess and low temperatures in temperate latitudes. During the declining or low phases of sunspot activity in the major 11-year cycles of the last two centuries, two thirds of the months have shown unseasonal warmth, while unseasonal cold has accompanied rising or high sunspot activity two thirds of the remaining time. We may tentatively accept the sunspots and the changes in solar radiation as a direct cause of weather shifts and of periods of unseasonable warmth and cold through the years. Whether the same influence lies behind the 2000-year cycles, and the Ice Ages and alternating Inter-Glacial Stages, still remains a matter of conjecture.

Sunspots are thus a matter of profound concern and have prompted investigations into the causes lying behind climatic fluctuations. As a result, we now know that each of the major planets of the solar system tends to depress sunspot activity on that part of the sun's surface exposed to a given planet. Observations have shown that sunspot activity decreases on any segment of the sun's face exposed to the earth during half of the sun's 28-day rotational period and increases on the opposite side during the other two weeks. Tides in the sun's gaseous mass have been believed to result from the varying planetary pulls, but there is also a possibility that other heavenly bodies may also exert potent influences.

Our personal fortunes through the years, as well as our health and energy, are thus linked to the sun and, through it, to the planets of our solar system—and perhaps to the nearer stars!

Today we pride ourselves upon our scientific achievements and the conquest of disease by men of medicine; yet months or years of unseasonable warmth bring devastating economic downturns against which we have found no defense, and at such times sickness and death rates decline, even while our physicians are least busy. Statistically, one might say that people are better off the less they see of a doctor, but in reality, it is the lessened storminess and reduction in bodily stress that account for the health betterment in hard times.

Man is in reality a pawn of the environmental forces encompassing him, being pushed forward to a vantage point at one time or held in lethargic bondage at another. Here is a challenge of the first magnitude—can human intelligence find an effective answer? If not an answer, then it should at least comprehend the forces at work and the major significance of their effects.

Evidences of Associative Interference in Psychomotor Performance[1]

Don Lewis, Alfred H. Shephard, and Jack A. Adams

Department of Psychology, State University of Iowa

UNEQUIVOCAL EXPERIMENTAL EVIDENCE of associative interference in the performance of a task predominantly motor in character was presented by Lewis (*4*) in a paper read at the 1947 meeting of the Midwestern Psychological Association. Lewis' subjects performed on a special model of the Mashburn apparatus built at Iowa. They first practised with the three controls in their usual setting. After attaining proficiency in the required task, they were given practice with all controls reversed. Following this reversed practice, they relearned the original task. Reliable decrements in performance appeared during the initial stages of relearning.

Buxton, in collaboration with Henry and Grant (*1, 2, 3*), had previously studied the effects of three different varieties of motor activity on acquired ability to perform on a Koerth-type pursuit rotor, but had found only *relative retroaction* and not actual decrements in ability to perform—decrements such as those easily demonstrated in verbal learning. In contrast to the decrements obtained by Lewis, Buxton could point only to amounts of gain in pursuit rotor performance following the interpolated activities which were different from the amount following a period of rest.

The Mashburn apparatus[2] in modified form seemed ideally suited to the studies of associative interference undertaken by Lewis. Basically, the unit consists of three double banks of small pilot lights and of a control stick and rudder bar. Each bank has a row of 13 red stimulus lights and a parallel row of 13 green response lights. Various combinations of stimulus lights come on automatically in random order, to provide patterns of red lights that must be matched by corresponding green lights. The three rows of green response lights are separately controlled by means of commutators and brushes associated with the stick and rudder bar. The green lights in any row come on and go off in succession as the corresponding control is moved in a given direction.

When a subject performs on the apparatus, he is presented with three randomly selected red lights, one in each of the three double banks. His task is to manipulate the stick and rudder bar until a green light is shining opposite each of the three red lights. When this condition prevails, a stepping relay operates automatically to bring up a new combination of red lights. This matching procedure may be continued for desired lengths of time; and the score a subject makes is the number of three-way matches accomplished during a trial period.

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[1] Studies of associative interference in psychomotor performance are being conducted at the State University of Iowa under Contract N5ori-57 with the Special Devices Center, Office of Naval Research.

[2] The apparatus was originally devised by Mashburn (*6*) for use in detecting flying aptitude. The Iowa model was constructed by Lewis for an investigation of the effects of noise and vibration on psychomotor responses (*5*). During the recent war, a somewhat improved form of Mashburn's original instrument was used extensively in the selection of air cadets and came to be known as the S. A. M. Complex Coordinator, a general description of which has been provided by Melton (*7*).

As first constructed for the study of noise and vibration effects, the Iowa apparatus, like Mashburn's original, was arranged to simulate the controls in the old-fashioned airplane and to provide a maximum amount of eye-hand and eye-foot coordination. The green lights in the curved bank at the top came on in order from left to right as the stick was moved from left to right. Sidewise motions of the stick constituted the so-called aileron control. Green lights in the vertical bank came on successively from above downward as the stick was pushed forward. Forward-backward stick movements constituted the elevator control. Pushing the rudder bar (the rudder control) with the right foot lighted the green lights in the bottom row in succession from left to right.

The Iowa model of the apparatus was modified to provide, through a number of convenient switches, for a reversal of the correct movement of each control. It was thus possible for Lewis to have his subjects practise for specified numbers of trials with the controls all set in their normal positions and then practise with all of the controls reversed. The interpolated practice, that is, the reversed practice, could be followed by relearning of the original task to discover the effects of the reversed practice. As previously indicated, Lewis' study yielded clear evidence of associative interference—evidence in the form of absolute decrements in ability to perform.

The decrements in performance were unmistakable, but they seemed far less extensive than would have been expected from the amount of confusion displayed by the subjects during the initial stages of relearning. Every subject was observed to make many false moves and yet the decrease in the number of matches was in some cases only slight. It was necessary to conclude that number of matches, as a measure of performance, was not sensitive enough to reveal the full extent of the interference effects. To increase the sensitivity of the apparatus, methods were developed for recording the number of false moves made by a subject immediately after each new combination of stimulus lights was presented. The three controls had to be placed in certain precise positions in attaining each three-way match. As soon as a match was made, a new combination of red lights appeared. The subject could then move each control either correctly or incorrectly—in the direction of the stimulus light or away from it. A movement of a control away from a light was counted as an error. It was thus possible for a subject to make three errors on each match. Separate error counters were provided for the three controls. The number of errors made during each trial period became a measure of performance along with the number of matches. The errors made on each of the controls can be studied separately or combined with those for the other two controls to yield a total error count.

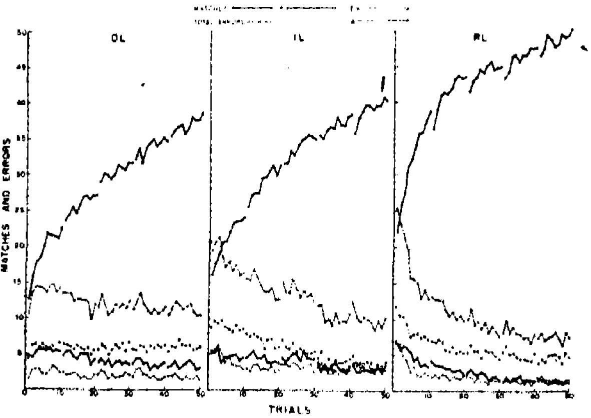

Fig. 1

The addition of the error counting procedure has added greatly to the usefulness of the Mashburn apparatus as a device for investigating associative interference.

As part of a rather extensive study of interference, eleven male students volunteered to take ten practice trials on the apparatus on each of 15 consecutive days. Each trial had a duration of two minutes. On each practice day, there was a rest period of two minutes between trials 5 and 6. All other trials were separated by a pause of 15 seconds. On the first five days (the first 50 trials), the subjects practised with the controls set in their normal positions. On the next five days (50 trials), the practising was done with the controls reversed. The original task was relearned on the last five days (50 trials).

The results for the eleven subjects are shown in Fig. 1, where mean number of matches and mean number of errors are both plotted as ordinates while trials are represented along the abscissa. There are separate plots for original learning, interpolated learning, and relearning. The upper curve in each case depicts the mean number of matches, while the heavy dashed curve (second from the top) shows total number of errors. The three lower curves are based on the mean number of errors made separately on the three controls, the control for each being indicated in the legend at the top of the figure.

During original learning, the mean performance of the subjects improved from 12.7 matches on trial 1 to 38.5 matches on trial 50. There was an initial increase in total number of errors from 10.5 to 14.4, then a leveling off for a few trials, and finally a slight downward trend. Most of the decrease in errors occurred on the rudder control.

At the outset of the reversed practice (interpolated learning), the mean number of matches was 16.0. The facilitation was undoubtedly the result of positive transfer. Positive transfer in the task was to be expected because the subjects, during original learning, became familiar with the general requirements and with the way the controls were best manipulated. Associative interference was also to be expected. The combinations of stimulus lights were the same for original and interpolated learning, but exactly opposite movements of the controls had to be made in response to the lights. The error curves provide clear evidence of interference at the beginning of reversed practice.[3] (The mean number of errors on trial 3 was 21.4.) Mistakes on all three controls contributed to the increase in total errors, but the contribution made by false moves on the elevator control was greatest. The subjects all reported experiencing the greatest amount of difficulty with the elevator control. As shown by the curves, there was a general trend downward in total errors and in errors on the elevator control during interpolated learning.

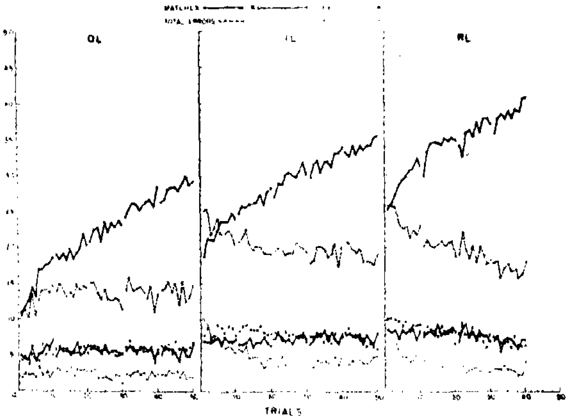

FIG. 2

At the outset of relearning, the mean number of matches was 22.0—a sharp reduction from the number on the last trials of original learning. The mean number of errors (25.3) was sharply increased. Mistakes were made on all of the controls, but the number made on the elevator was again conspicuously large. The decrease in number of matches and the increase in errors both pointed unmistakably to the functioning of associative interference. The interference effects were largely dissipated by the end of the first day of relearning, although remnants of them probably persisted into the third or fourth day. The reduced number of matches on the first and second trials of days 2, 3, and 4 of relearning may have arisen from lack of warm-up, but may have resulted in part from a recovery of interference effects during 24-hour periods without practice.

Evidences of associative interference similar to but less conspicuous than those displayed in Fig. 1 may be seen in Fig. 2, where results are presented for a group of nine male students given practise on 14 consecutive days[4] on the Mashburn apparatus with a different arrangement of the controls. On the Iowa model, it is possible to connect any one of the three controls to any one of the three banks of lights. When the data for Fig. 2 were collected, the rudder bar controlled the upper curve bank of green lights, while the aileron and elevator controls were associated with the vertical and horizontal banks, respectively. The resulting task was somewhat more difficult than the one arising with the standard arrangement of the controls. This greater difficulty was revealed not only by the smaller number of matches made after equal amounts of practice but also by a somewhat greater number of errors. The functioning of positive and negative effects at the outset of interpolated learning may be readily inferred from the data, and the functioning of associative interference during relearning is unmistakably revealed.

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[3] Initial performance on the Mashburn apparatus with the controls reversed had been shown to be quite similar to initial performance with the controls in their normal position.

[4] Five days (50 trials) of original learning, five days (50 trials) of interpolated learning, and four days (40 trials) of relearning.

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TECHNICAL PAPERS

Ultraviolet Action Spectrum of T1 Bacteriophage

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T1 bacteriophage is a self-duplicating organism of remarkable stability. In the presence of a small amount of dried broth it can be maintained dry almost indefinitely. Advantage has already been taken of this to study the target size for deuteron inactivation (*5*). This target appears to be smaller than the whole bacteriophage particle. It is therefore of some interest to study the relative effectiveness of ultraviolet light in causing inactivation. Such studies have been made by Gates (*1*) on *S. aureus* bacteriophage and by Hollaender (in *3*) on various bacteria. A recent review of the significance of ultraviolet action spectra has been given by Loofbourow (*3*).

If the number of bacteriophage particles initially present is n_0 and after receiving an intensity I for a time t a number n survive then the relation

$$\frac{n}{n_0} = e^{-aIt}$$

holds where a is a constant for any one wavelength. This relation requires the random absorption of photons and applies only if the bacteriophage layer is uniform, the ultraviolet light is uniform, and there is no absorption by broth. Results indicate that if allowance is made for departure from these conditions, the relation is obeyed.

Our procedure has been to measure a for a series of wavelengths of light given by a quartz mercury arc and the resulting plot of a versus wavelength is the action spectrum.

Bacteriophage assays are made by plaque counts, the bacteriophage being mixed with *E. coli* and agar sufficiently warm to spread out on a Petri dish. The agar, coli, and bacteriophage mixture is then incubated at 25° C for about 8 hr and the plaques counted. We are indebted to Mrs. Marjorie Beaume for almost the whole of the preparation and plating work.

Selection of a particular wavelength was by means of a monochromator built according to a design by Harrison (*2*). It consists of an aluminized concave mirror placed at a slant under a water surface. A U-A2 uviarc is the principal light source used and the intensity of the emergent beam is monitored with a photocell which has been calibrated against a thermopile.

The results were compiled from seven runs, during which time some modifications of equipment and technique were made. The spectral dependence was found to be similar in spite of change of area, renewal of the mirror surface, and change of the amount of dried broth in which the bacteriophage was irradiated. Full energy calibration was only carried out in the last few runs.

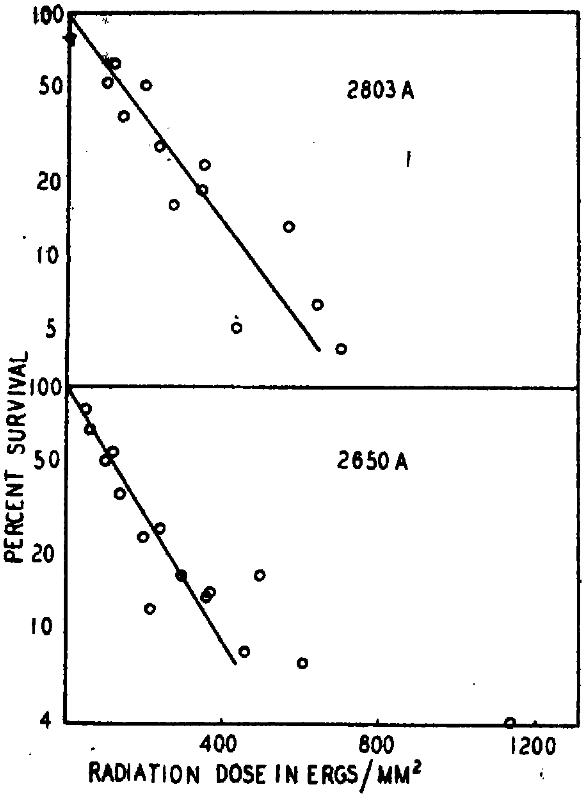

FIG. 1. Representative inactivation curves in which the logarithm of the percent survival is plotted against the radiation dose. The logarithmic relation holds over a factor of ten. At shorter wavelengths absorption in the broth, combined with sample inhomogeneity, causes a departure at high dose figures.

In order for a to be a valid indication of sensitivity, the rate of inactivation with energy dose must follow the relation given. Unless irradiation is at the same intensity for all wavelengths, the validity of doses as products of intensity and time must also be considered. Curves are shown in Fig. 1 for wavelengths 2650 A and 2803 A. Data are included for three runs, for which the intensity was varied over a factor of 2.5. Within the dispersion of the data, reciprocity of time and intensity appears to be acceptable. The dispersion for these runs is at least partly statistical, since control plaque counts were about 100. Treatment of the data as logarithmic also appears valid, at least to the 37% point at which a is determined. At longer wavelengths individual curves were even more accurately logarithmic.

At 2650 A and shorter wavelengths a positive curvature at lower survivals is noticeable. Decrease of the amount of broth on each irradiation strip from .05 to .01 ml reduced this curvature from 20 or 30% survival to below 10%. Absorption in the broth film is the most probable explanation, for although an absorbing film of uniform thickness would still give nearly logarithmic inactivation (*4*), we were not able to obtain consistently uniform broth layers. The difficulty of measurement and transfer of these small volumes is the most likely cause of the dispersion of the points on our inactivation curves.

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[1] U. S. Public Health Fellow.

TABLE 1

λ, A	3664	3131	2967	2894	2803	2760	
37 % dose, ergs/mm²	~100,000	30,000	1200	750	220	224	
λ, A	2700	2650	2540	2482	2400	2350	2250
dose	207	185	232	455	628	327	600

The calibration of intensity in absolute units must be considered less accurate than the relative intensities of various wavelengths. The energy doses in ergs/mm² for reduction to 37% survival are shown in Table 1. The action spectrum plot is given with *a* calculated for *It* expressed in quanta/mm².

The results are very similar to those obtained by Gates. The features to note are the minimum at 2425 A, which is rather long in wavelength for desoxyribose nucleic acid, and the rather high inactivation at 2800 A. The value of *a* appears to fall at 2250 A, but this may be apparent and not real, since there can be heavy broth absorption. We do not believe that there is a sharp rise corresponding to protein absorption, however, as the broth absorption as estimated by rough measurements could hardly have exceeded a factor of two.

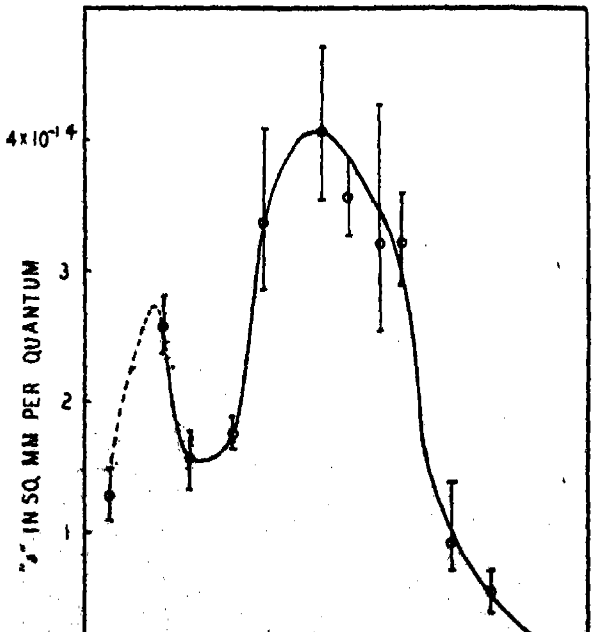

FIG. 2. Relative effectiveness of various wavelengths of ultraviolet light in causing inactivation of T1 bacteriophage.

A comparison with work on bacteria as tabulated by Hollaender can be made. Our figure for the 10% dose at 2540 A is 535 ergs/mm². This shows that dried T1 bacteriophage is less susceptible at this wavelength than vegetative bacteria, but more so than spores.

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Lysis of Formalinized Bacteria by Bacteriophage

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Recently it has been pointed out (*1, 2*) that many lysed cells are found in mixtures of young and actively growing cultures of the B strain of *E. coli* with suspensions of certain bacteriophages when such mixtures are chilled and prepared for electron microscopy after very short incubation. After longer incubation stages in the development of new bacteriophage, particles are evident in such masses of lysed protoplasm. We have now found that the same phenomena of bacterial lysis and bacteriophage production are observed using bacteria previously inactivated with formaldehyde.

The bacteria used were 1 to 1½-hr cultures in tryptose broth. They were inactivated by being held for 15–30 min at room temperature after the addition of the desired volume of commercial formalin. Then the cells were washed once or twice by putting them in fresh broth and sedimenting them in a centrifuge. The washed suspension was made up to have a turbidity approximately that of the original culture. Effectiveness of the formalinization was tested in each instance by streaking a loop of this suspension on an agar plate and incubating. Such test plates remained completely free of bacterial growth when a concentration of 0.2% or higher of formaldehyde was employed; a few isolated colonies sometimes developed if the formaldehyde concentration was 0.04 or 0.08%. Such suspensions of killed, washed bacteria become clear on incubation following the addition of a suitable bacteriophage suspension containing enough particles to infect the bacteria present. Samples for electron microscopy were withdrawn after periods of incubation up to 1 hr, immediately chilled in ice water, and centrifuged cold, and the sediment was washed by successive centrifugations first from 0.5% formalin-saline and then from water-formalin. Final suspensions in a small volume were spread and dried in the usual formvar-covered grids and metal-shadowed for electron microscope examination.

What was seen depended on the strength of the formaldehyde used for inactivation. At all concentrations up to the highest tried (1% formaldehyde = 2.5% formalin) there was the same picture of extensive cell rupture after short incubation that was observed with living bacteria. The masses of bacteriophage particles in the ruptured bacteria of many preparations further demonstrate beyond question that bacteriophage has proliferated during incubation with killed organisms. Electron microscopic evidence for such proliferation has been clear for both T2 and T4 bacteriophages; none could, on the contrary, be found in numerous experiments with T3 bacteriophage, though lysis evidently had occurred. The number of new bacteriophage particles depends obviously on the strength of the inactivating formaldehyde. As far as can be judged by electron microscopy, bacteria treated with 0.04% formaldehyde support as extensive bacteriophage multiplication as do living bacteria; the number of new particles appears diminished at concentrations above 0.2% formaldehyde and is greatly reduced and perhaps completely arrested at the highest concentration used (1%). It is also greatly lowered if the killed bacterial suspension is allowed to stand for several hours before the addition of infecting bacteriophage.

It has been instructive to determine by plaque counting the number of viable bacteriophage particles in these lysed suspensions of inactivated bacteria. They depend, even more strikingly, on formaldehyde concentration. With all but the minimal amount of formalin, the recoverable particles were far fewer than those added to bring about lysis, but after inactivation with 0.04% formaldehyde the yield often greatly exceeded the input. Thus in one experiment where suspensions containing 10^{8} killed bacteria per ml were inoculated with approximately 10^{9} particles of T4 per ml, the yield was reduced to about 0.01 the inoculum when the killing concentration of formaldehyde was 0.2%; it about equaled the inoculum when it was 0.08%; and it was about tenfold greater when it was 0.04%. Evidently the newly formed bacteriophage particles that the electron microscope shows developing from the more strongly formalinized bacteria either do not fully mature as independent infectious units or they are themselves gradually killed by the formalin-treated protoplasm which they have consumed.

Light on this point can be drawn from studies we made of the relative sensitivities of different bacteriophages to formaldehyde. These demonstrated, for instance that whereas the titer of a suspension of T2 or T4 was reduced to much less than 10^{-5} of its initial value by contact for 15 min with 0.2% formaldehyde, most particles in a suspension of T1 withstood 1.5% formaldehyde for at least one hour. Notwithstanding this remarkable resistance of T1 bacteriophage and its ability to lyse formalinized bacteria, its titer after such lysis was as dependent on the concentration of formalin used for bacterial killing as was that in the corresponding experiment with formalin-sensitive T2 or T4 bacteriophages..

These experiments on the development of particles of bacteriophage at the expense of bacteria that were inactivated by formalin have a direct bearing on the nature of this inactivation, as well as on the nature of bacteriophage and its mode of multiplication. They do not yet give a sufficient answer to any of these questions, but they definitely prove that certain bacteriophages can proliferate on bacteria that have been killed in the sense of having been rendered unable to develop into visible colonies. Other methods of experimentation will be required to show whether in this case bacteriophage is actually multiplying on already dead or on dying cells.

These studies are being extended to other circumstances of bacterial killing and will be reported elsewhere.

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Granulosis Disease in the Buckeye Caterpillar, *Junonia coenia* Hübner

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The first reported instance of a granulosis disease of an insect in the Western Hemisphere was that found occurring in the variegated cutworm, *Peridroma margaritosa* (Haw.), which was being reared in an insectary in California (*2*). In September 1948, several specimens of the buckeye caterpillar, *Junonia coenia* Hübner, collected near Westley, California, and brought into the laboratory were found to be infected with what also appeared to be a granulosis virus. This observation was confirmed by the microscopic demonstration of characteristic granules in the diseased host tissues, and by electron microscope demonstration of the virus particles in the granules.

In general, the disease and the accompanying granules in *Junonia* are very similar to those of *Peridroma*. Cross infection experiments, however, showed that the two diseases were not identical, since neither host is susceptible to the virus of the other. The *Junonia* virus is also apparently distinct from those causing granuloses of several European insects (*3*). Diseased *Junonia* appear brownish in color and lose their characteristic metallic blue-black luster. The time from the beginning of the infection to the death of the insect varies considerably and may be rather prolonged. As a rule, death results in 6–12 days after infection. Dead larvae "hang up" on the food plant or die on the ground or on the bottom of the rearing cage. The integument usually remains intact.

When the integument is ruptured, the body fluid flows out rapidly and if the disease has progressed far enough the fluid has characteristic milky appearance. When examined with an ordinary compound microscope the fluid was seen to be filled with large numbers of small granules. Microscopic examination of pieces of the fat body showed granules present in cells of this tissue. Electron micrographs of these materials showed the granules to be ovoid bodies about 350 × 500 mμ in size (Fig. 1A).

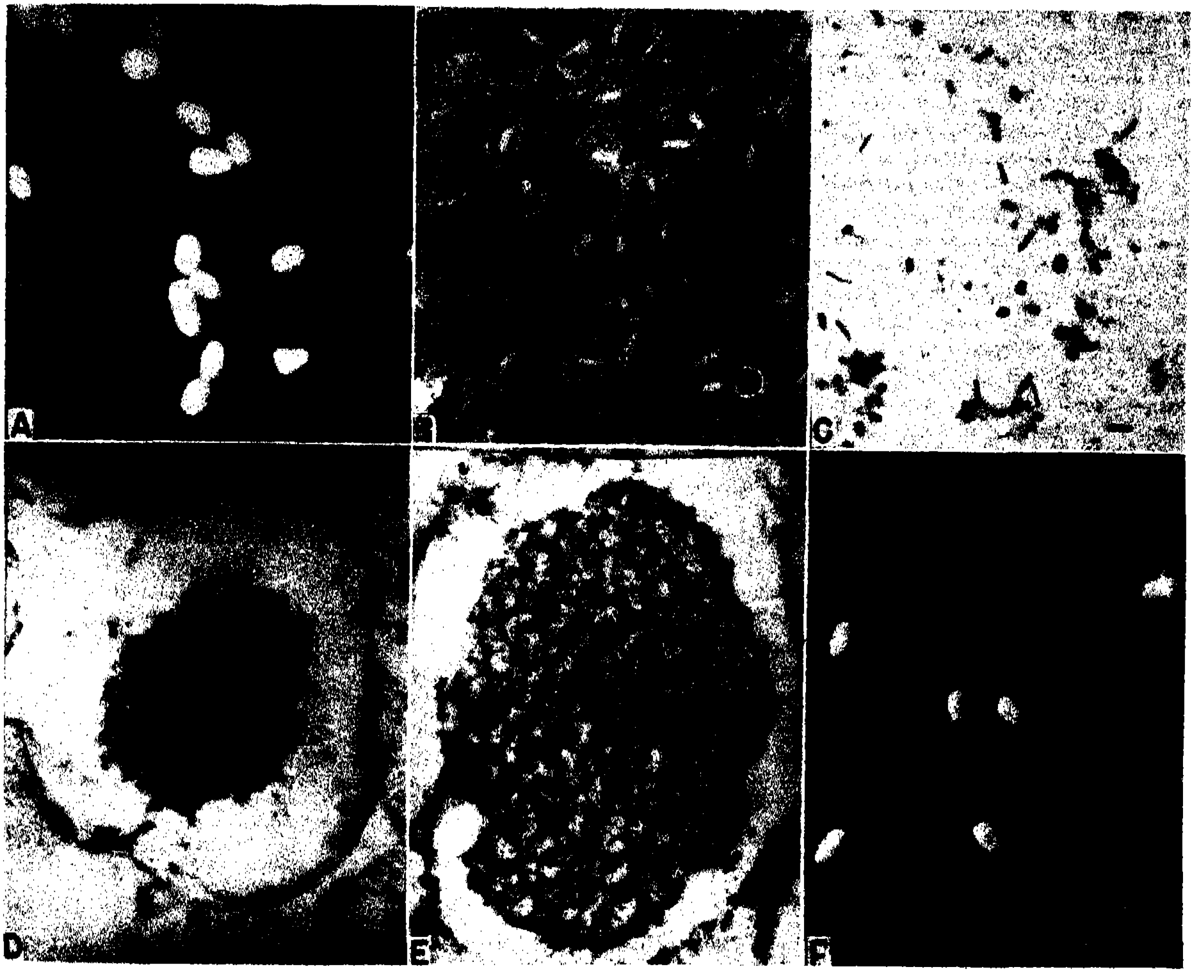

FIG. 1. A. Granules characteristic of the granulosis of the buckeye caterpillar, *Junonia coenia* Hübner. B. Granules partially dissolved in 0.05 M sodium carbonate solution, showing the location of virus particles, which are still covered with some of the granular material. C. Preparation in which the granular material has been completely dissolved, leaving the free rod-shaped virus particles. D. A single fat-tissue cell showing the nucleus slightly hypertrophied and beginning to disintegrate. The cytoplasmic area of the cell is occupied by large fat globules. E. Fat-tissue cell later in the disease, nucleus greatly hypertrophied. F. Granules from salt marsh caterpillar, *Estigmene acraea* (Drury), suffering from ganulosis. A, B, C, and F, electron micrographs, magnifications approximately 10,000 ×; A, B, F, gold shadowed. D and E, ordinary photomicrographs, magnification approximately 1,100 ×. (Photographs by K. M. Hughes and H. B. Wasser.)

In order to demonstrate the virus particle enclosed within the granule, the same technique as that used with *Peridroma* granules (*4*) was applied here. With the use of Na_2CO_3 in a concentration of 0.05 M for 3 hr, the granules dissolved, revealing a rod-shaped virus particle enclosed within each granule, approximately 40 × 300 mμ in size. With certain preparations electron micrographs were made during the dissolving process, showing the virus particle still surrounded by some of the granule material. Such preparations indicate that the virus particle is freed from the granule simply by the dissolving away of the granular material. Working with the granulosis virus of *Cacoecia murinana* Hüb, Bergold (*1*) believed that in some cases, at least, the virus slips out of the particle when under the influence of the alkaline solvent. The writers have not observed such action with either the *Peridroma* or *Junonia* granuloses viruses.

Histopathological studies of diseased *Junonia* caterpillars showed the fat tissue to be the principal one affected by the disease, although at times other tissues such as the hypodermis and tracheal matrix were also involved. Sections of diseased larvae were fixed in Bouin's or in Carnoy's fixative and stained with iron hematoxylin or with Mallory's triple stain. In such preparations, the nuclei of the fat cells were prominently altered in appearance. As the infection progressed, the nuclei became hypertrophied, usually to a marked degree. The chromatin material of such nuclei underwent karyorrhexis and karyolysis and became diffused throughout the nuclear area. Granules, characteristic of the disease, seemed to be forming in the enlarging nuclei, and sometimes the greatly enlarged nuclei appeared to be liberating granules into the cytoplasm of the cell. At other times the nucleus appeared intact and yet some granules were present in the cytoplasm. The granules possibly originate within the nucleus and sooner or later accumulate in the cytoplasm. At any rate, the hypertrophied nucleus eventually breaks down and disintegrates, at which time the granules may be seen distributed throughout the nucleoplasm and cytoplasm of the host cell.

Until the hypertrophied nucleus disintegrates it seems to be held intact or at least to be supported within the nuclear membrane by the fat globules pressing against all sides of the nucleus. Such a situation is not so apparent in the case of *Peridroma* granulosis. In the *Junonia* cells, however, the cytoplasm is almost entirely occupied by the globules of fat (Fig. 1, D, E) leaving very little room for the granules which, in the *Peridroma*, accumulate in large numbers in the cytoplasm of the cell.

In the later stages of the infection there seem to be fewer fat globules in the cytoplasm, which now may be fairly well filled with granules. Finally the cell membranes themselves break down, liberating the granules and other contents of the cells into the body cavity of the host insect. A few chromatin remnants may be seen scattered about in the almost completely disintegrated tissue. It is at this time that the insect dies.

Shortly after the *Junonia* granulosis was found, a similar infection was discovered in specimens of the salt-marsh caterpillar, *Estigmene acraea* (Drury) collected in Albany, California. Whether the disease is caused by the same or another virus is not yet known.

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A Filter Paper "Chromatopile"[1]

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The application of one- and two-dimensional paper chromatography to the separation of small amounts of many kinds of compounds has become a well-established and useful technique (*1, 2, 3, 5, 6*). In general these methods do not handle sufficiently large quantities of materials for isolation and chemical identification. Large columns of starch and other materials have been used satisfactorily for handling larger quantities of mixtures (*4*). Starch columns proved to be unsatisfactory, however, for isolation of certain substances under investigation in this laboratory. As a consequence, a new and simple apparatus and technique have been developed, using a pile of filter paper disks as the absorbing column.

A diagrammatic sketch of a cross section of the column is shown in Fig. 1. It consists essentially of three parts: the pile of filter paper itself (No. 7 in Fig. 1), a clamp for packing the paper tightly, and the solvent distributor at the top of the pile. The metal parts are constructed from stainless steel. The solvent distributor is connected by a siphon of rubber tubing to a 2-l flask containing about 1 l of solvent mixture. The flask is adjusted so that the level of the solvent is even with the top of the paper pile. In operation the column is placed upright on the ends of the clamp bolts in a 9 in. × 12 in. battery jar containing about 200 ml of solvent mixture. The jar is covered, with a hole left for the siphon tube.

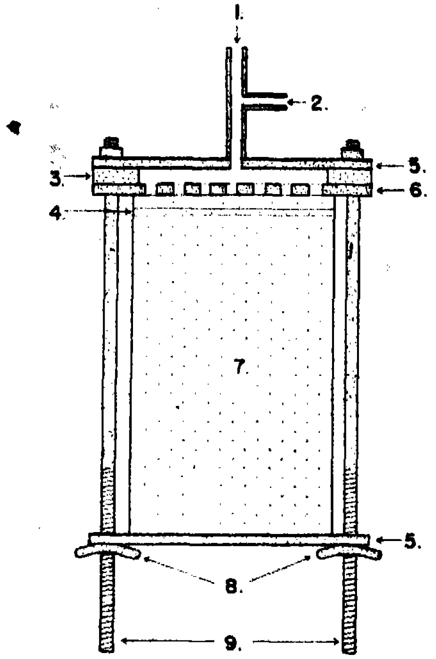

Fig. 1. Diagram of the filter paper pile column. 1. Connection for a rubber tube for filling the siphon. 2. Connection for the siphon tube. 3. Rubber gasket. 4. Filter paper disks containing the sample. 5. Stainless steel plates. 6. Perforated stainless steel plate. 7. Filter paper disk pile. 8. Wing nuts. 9. Bolts at four corners of steel plates.

The results of a trial run on known compounds will serve to illustrate the utility of the apparatus. Fifty mg each of adenine, tryptophane, phenylalanine, *p*-aminocinnamic acid, and anthranilic acid was dissolved in 20 ml of 0.1 N HCl and the solution was placed in the lid of a 100-mm Petri dish. Disks of 9-cm Whatman No. 1 filter paper were immersed in the solution, allowed to drain, and hung up to dry in air at room temperature. Twenty-five sheets were required to take up the solution and rinsings. To prepare for packing the column, the bottom plate of the clamp was removed and the clamp placed in an inverted position with the solvent distributor down. Forty filter paper disks (9 cm diam) were then placed carefully in the center of the perforated plate, followed by the 25 dried sheets containing the sample. The remainder of the column was made up of a pile of

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8 packages of filter paper (9 cm, Whatman No. 1; total, 865 sheets). After careful alignment of the paper disks, the bottom plate of the clamp was placed on the pile and the wing nuts tightened as much as possible without mechanical aid. The column was then placed in the battery jar with the solvent distributor up. The distributor was then filled with the solvent mixture (3 parts *n*-butanol; 1 part *tert*-butanol and 1 part of 0.1 N HCl) with a pipette, and the siphon from the solvent container was connected and filled. After 28 hr the solvent front had descended 13.2 cm. The column was then removed from the jar and the pile taken out in sections. After the approximate locations of the five compounds had been determined by qualitative means, disks were taken 6, 10, or 20 at a time and extracted with hot 0.1 N HCl for adenine, tryptophane, and phenylalanine and hot 0.1 N NH_4OH for the remaining two compounds. Adenine, tryptophane, and *p*-aminocinnamic acid concentrations in the extracts were determined with the Beckman Spectrophotometer. Phenylalanine was determined colorimetrically with ninhydrin, and anthranilic acid fluorometrically with a Coleman Photofluorometer. The total recoveries of compounds from the column sections analyzed were: adenine, 41 mg; tryptophane, 46 mg; phenylalanine, 46 mg; *p*-aminocinnamic acid, 44 mg; and anthranilic acid, 46 mg. Thus, without considering losses in sheets removed for qualitative tests, 223 mg was recovered from the original 250 mg in the mixed sample. The distribution of the compounds on the column is shown in Fig. 2. As noted in the figure, the solvent traveled from the last sheet of the mixed sample through 730 filter paper disks or a distance of 11.8 cm. In the case of the sharpest peak (phenylalanine) more than 95% of the compound recovered was found in 36 filter paper disks representing a thickness of a little less than 6 mm. With such a degree of resolution it is clear that the solvent front movement is remarkably uniform in this type of column. Color tests made directly on sample disks showed a slightly more rapid movement of solvent at the edges, but the difference in rate is apparently negligible.

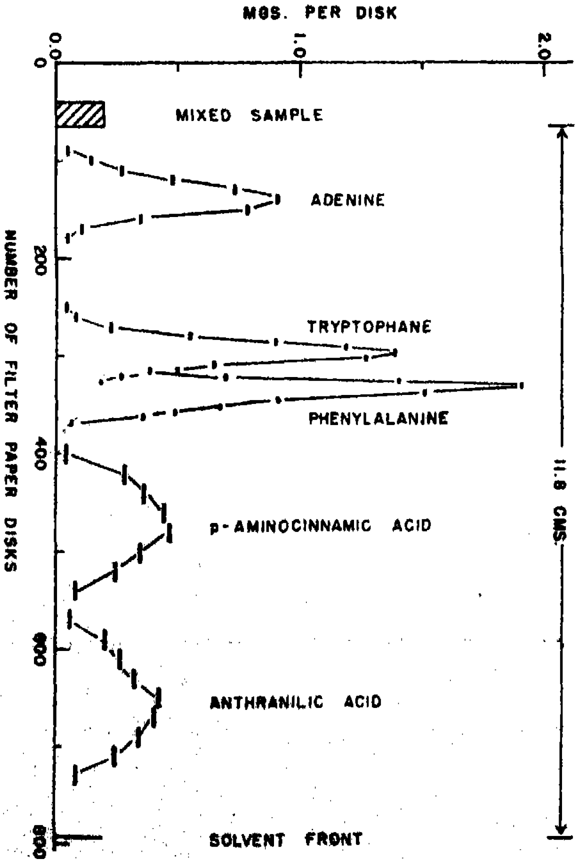

FIG. 2. Results of an experiment showing the separation of compounds of a known mixture. The length of the horizontal bars used for experimental points indicates the number of paper disks extracted for each analytical sample.

The simplicity and ease of operation of the filter paper pile column provides a practicable method for isolations without requiring complicated equipment. One feature which is most desirable is the ease with which a sample can be removed and incorporated into a new pile. Thus, a section of disks containing a desired compound can be taken out and placed in a new pile for use with a different solvent mixture.

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Tryptophane as an Intermediate in the Synthesis of Nicotinic Acid by Green Plants

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The paper by Beadle, Mitchell, and Nyc (*2*) demonstrating that certain selections of *Neurospora* are able to synthesize nicotinic acid from tryptophane suggested to the writer that higher green plants might also have this ability, but only recently was it possible to set up such an experiment. That tryptophane is a precursor of nicotinic acid has now been quite conclusively demonstrated for a number of organisms. Nason (*7*) has very recently demonstrated that corn embryos are able to synthesize this vitamin when supplied with tryptophane and vitamin B_6. Several investigators have shown that animals can also use tryptophane in the synthesis of nicotinic acid (*6*, *8*, *9*), and there seemed to be no good reason why green plants could not do likewise.

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[1] Paper No. 890 from the Department of Botany of the University of Michigan. This investigation has been aided financially by the U. S. Public Health Service, and some of the chemicals have been supplied by Merck and Co.

Leaves of cabbage, broccoli, and tomato plants grown in the greenhouse were used as plant material. The tryptophane was supplied to intact leaves through the petioles, which were dipped into the solution. Nicotinic acid was determined by the microbiological method using *Lactobacillus arabinosus* as the test organism. The procedure as outlined in *Methods of vitamin assay* (*1*) was followed. The time allowed for synthesis to take place was usually about 48 hr, though longer and shorter periods were also used. Three days were too long, as the leaves wilted and the plants were not at their best; and usually more vitamin was obtained in two days than in one. Concentrations of DL-tryptophane ranged from 0.025 to 0.10 % L-tryptophane. These concentrations may seem a little high but since the experiments cannot be run very long it has seemed best to have high concentrations and get a high rate of nicotinic acid synthesis. No attempts have been made to study the relation between concentration of tryptophane and concentration of nicotinic acid obtained. Table 1 gives the results of these experiments.

TABLE 1

SYNTHESIS OF NICOTINIC ACID BY GREEN PLANTS FROM TRYPTOPHANE*

Plant	Time in hr	Concentration of tryptophane in %			
		0	0.025	0.05	0.10
Broccoli ..	26	9.22		9.35	9.92
	47	8.18		8.53	
Cabbage ..	70	8.25	9.73	9.92	
	98	7.52	7.98		
	43	6.94		7.49	7.20
	47	6.65	8.25	7.81	7.43
Tomato ...	48	5.14	6.08		
	22	4.44	4.69		
	24	5.81	5.70	6.86	
	47	5.05	6.18	5.99	
	25	5.46	6.35	6.70	
	40	6.36	7.40	8.64	
	48	6.57	6.62	6.80	
	71	6.04			7.10
	48	5.18	6.12	7.60	7.64
	47	4.40	5.70	5.63	
	48	4.75	5.35	5.90	
	48	3.62		4.56	5.10

* The figures denote µg of vitamin/g of fresh plant material.

TABLE 2

SYNTHESIS OF NICOTINIC ACID FROM TRYPTOPHANE BY GREEN PLANTS IN DARK AND IN LIGHT*

Plant	Concentration of tryptophane in %					
	in light			in dark		
	0	0.05	0.10	0	0.05	0.10
Tomato ..	3.64	4.56	5.10	3.26	3.93	4.71
	4.98	5.72	6.72	4.47	4.93	6.32
	6.07	6.67	6.83	4.05	5.06	5.76
Cabbage ..	6.94	7.49	7.20	6.25	6.69	6.96

* Figures denote µg of vitamin/g of fresh material.

While only a few experiments were done with broccoli and cabbage and there is not a constant increase in nicotinic acid assayed with increase in concentration of tryptophane supplied to the plants, there is, nevertheless, no doubt that the three plants used have synthesized nicotinic acid from tryptophane, which is all that the writer is attempting to show. The variation in amount of vitamin in different experiments is due, as has been pointed out (*4*), to differences in age of leaves used.

Another observation, which has nothing to do directly with nicotinic acid, should be recorded. When 4–5-in. tips of tomato plants with their young leaves were put in higher concentrations of tryptophane, the young immature leaves showed unmistakable signs of response to growth hormones. They curled up much as they would if the stem had been supplied with indoleacetic or butyric acid. They had evidently synthesized a growth hormone from tryptophane. This has been shown before but only under special circumstances.

The writer has previously shown (*5*) that light influences the synthesis of thiamin and riboflavin by green plants, and unpublished data indicate this may be true also for nicotinic acid. Experiments were therefore set up in dark and in light. Table 2 presents the findings.

Evidently light is not a factor in this synthesis. Recently Bonner (*3*) has outlined a scheme for the synthesis of nicotinic acid from anthranilic acid. He does not, however, state how anthranilic acid might be formed from the products of photosynthesis.

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Relation of Sporadic E Reflection and Meteoric Ionization

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One of the purposes of the radio-meteor research program at the Central Radio Propagation Laboratory of the National Bureau of Standards is to determine to what extent meteoric ionization may be responsible for sporadic E reflections from the ionosphere. Various investigators (*1, 3, 4*) have proposed that sporadic E reflections are caused by ionization produced in the atmosphere by meteors. Observations made up to the present time at this laboratory fail to support this view.

Since radio-meteor observations were begun at this laboratory (*2*) special equipment for the purpose has been constructed and placed in regular operation. It consists of two transmitters and receivers operating on 27.2 and 40.98 mc/s emitting pulses with a peak power of 10 kw. Reflections of the pulses by meteor trails are displayed on a cathode-ray oscilloscope and simultaneously recorded on two recording milliammeters. The emitted pulses are approximately 50 microseconds in width and the pulse repetition rate is 60/sec. Duration of the sweep is adjustable to a maximum of 4 milliseconds. The antennas are half-wave horizontal dipoles spaced a quarter wavelength aboveground, thus directing the radiation predominantly upward in accordance with the well-known pattern of these antennas. Separate but similar antennas are used for emitting and receiving.

Multifrequency ionospheric records are obtained continuously at the Sterling, Virginia, station where the meteor equipment is installed. Sweeps over the frequency range 1–25 mc/s are made regularly every 15 min. The multifrequency transmitter's pulse width, pulse repetition rate, and peak power output to the antenna (but not necessarily its radiation therefrom) are approximately the same as for the meteor equipment. The antenna is a modified rhombic, oriented so that the main lobe is directed upward. Although no direct measurements of the antenna pattern have been made, it is known that the directivity of the antenna and its radiation efficiency change with frequency. At the lower frequencies this effect reduces the power radiated in the desired direction. Strong interference is encountered from other broadcasting stations in the frequency range between 1 and 2 mc/s. Because of this interference and the relatively poor radiation efficiency at these frequencies the receiver, which is not sharply tuned, often does not obtain reflections even from the normal ionosphere layers at the lower frequencies. The time required to sweep over the frequency range 1–25 mc/s was 15 sec during these observations.

On numerous occasions, the operation of the multifrequency ionospheric equipment has been visually observed while meteors were being recorded with the regular radio-meteor equipment. In general, no relation was observed between the occurrence of sporadic E reflections on the multifrequency equipment and reflections from meteor trails on the other apparatus. On certain occasions, however, records of reflections from the multifrequency equipment have been obtained coincident in time and range with reflections received on the meteor equipment and also, in some cases, with visually observed meteors. These reflections resemble sporadic E reflections, and could be so interpreted, although distinct differences between the two types of records can be seen.

An excellent illustration of these differences was obtained during the November 1948 Leonid meteor shower. The meteor equipment was in operation on both frequencies.

On the morning of November 15, 1948, at 0056 eastern standard time, a high intensity meteoric reflection was visually observed on the monitor oscilloscope, simultaneously on both frequencies at a distance of 125 km, continuing for 4 min on the lower frequency and for 2 min on the higher frequency. At 0058 eastern standard time, the multifrequency equipment was turned on manually and showed, in addition to the regular F2 reflections, regular sporadic E reflections at a virtual height of 100 km which had been prevalent all night, and also another reflection at a virtual height of 125 km, which extended to a somewhat higher frequency. The appearance of this 125-km reflection, coincident with echoes seen at the same range on the meteor-recording equipment, seems to be sufficient evidence that what appeared as a layer at a height of 125 km was indeed the ionized trail of a meteor. These reflections varied considerably in intensity. It is to be noted that the echoes had already disappeared on 40.98 megacycles and were beginning to fade rapidly on 27.2 megacycles at the time the regular ionosphere recorder was turned on. Approximately 2 min later the ionosphere recorder came on automatically, making two consecutive sweeps, both of which showed sporadic E reflections at 100 km but neither of which showed the 125-km reflection which appeared earlier. A previous sweep, made at 0045 eastern standard time, showed faint sporadic E reflections at 100 km but nothing at 125 km.

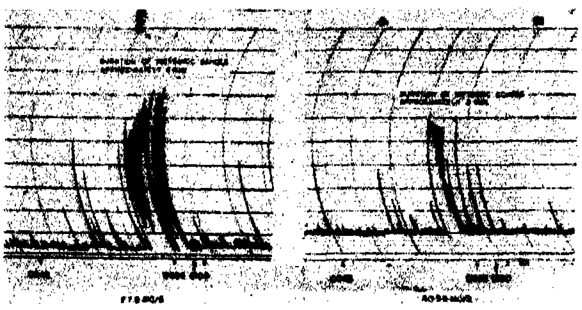

FIG. 1. Meteor record November 15, 1948.

Fig. 1 shows portions of the traces from the recording milliammeters on the two operating frequencies on which the record of the meteor appears. The pips on the lower margins are placed there automatically whenever the multifrequency ionosphere recorder is turned on. Fig. 2 is a reproduction of the photographic record made by the multifrequency equipment, (A) at 0045 eastern standard time, (B) at 0058 eastern standard time, showing the 125-km reflection attributed to the meteor trail just above sporadic E reflections from 100 km, and (C) at 0100 eastern standard time, at which time the 125-km reflection had almost entirely disappeared, although the sporadic E reflections were still present with considerable strength.

The meteoric reflection appearing in the E region of Fig. 2B resembles a sporadic E reflection in that there is no characteristic cusp indicating a critical frequency. However, comparison of this trace with that produced by the true sporadic E reflection shown in Figs. 2B and 2C shows that the meteoric reflections, though weaker, are also more sharply and clearly defined than the sporadic E reflections. The discontinuous character of the reflections, as a function of frequency, from the meteor

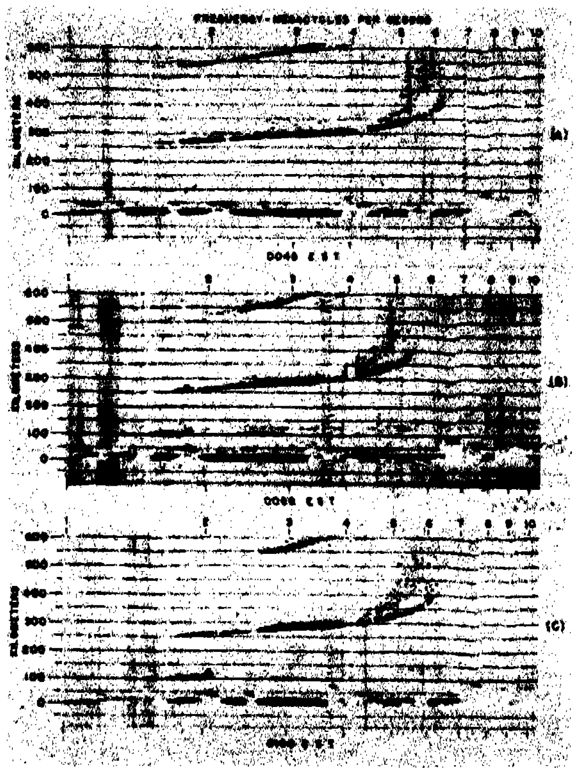

FIG. 2. Ionosphere recordings at Sterling, Virginia, on Nov. 15, 1948, showing sporadic E reflections at 100 km, and reflection from meteor trail (in B) at 125 km.

trail and the absence of reflections at lower frequencies are attributed to variations in antenna radiation with frequency previously described. It is presumed that in the absence of this and similar difficulties inherent in operation of automatic multifrequency equipment, reflections from the meteor trail would have been obtained even at the lowest frequency.

Since November 15, reflections on the multifrequency equipment produced by meteors have been frequently observed, often at times when true sporadic E reflections were entirely absent, as evidenced by continuous sweeps of the multifrequency recorder covering the period prior to the appearance of reflections on the meteor equipment and carried on through until their disappearance. Records obtained on the night of December 12, 1948, are shown in Fig. 3. In this case true sporadic E reflections were obtained from a height of 100 km and a meteoric reflection shown in Fig. 3B at approximately 80 km. The records of Fig. 4 were made on December 13, 1948, at a time when no sporadic E was present. In both cases the multifrequency equipment was turned on by the operator at the appearance of strong reflections on the meteor equipment. In both cases the reflections attributed to the meteors were from an apparent height agreeing with the range observed for the meteors.

An examination of the photographs of Fig. 3 reveals several interesting characteristics of meteoric reflections in comparison with those from sporadic E. The sharp definition of the meteor trace previously mentioned is again demonstrated. Also noticeable is the fact that the sporadic E reflections begin to appear at a lower frequency than those from the meteor. This effect is probably due to the radiation pattern of the antenna used with the multifrequency equipment previously described and the comparatively small target area presented by the meteor trail. Another feature of Fig. 3B is the appearance of two M reflections. At the frequency of 3 mc/s, used as a convenient reference abscissa, one sees a reflection at 375 km, which corresponds to the M reflection involving the sporadic E reflection as seen in Fig. 3A at about 100 km, and another at 415 km, which is attributed to the meteor.

In this second case the simple relationship, 2F minus height of meteor, would indicate a height of only 55 km for a meteor directly overhead. The implication is that the meteor was to one side of the observing location at a slant range equal to the 80-km direct reflection but at a somewhat lower true height. In this case the simple relationship, 2F minus height of meteor, does not yield the apparent height of the M reflection involving the meteor trail, indicating that the meteor reflections were not from a point directly overhead, and that the true height of the meteor was somewhat less than indicated by the direct reflection.

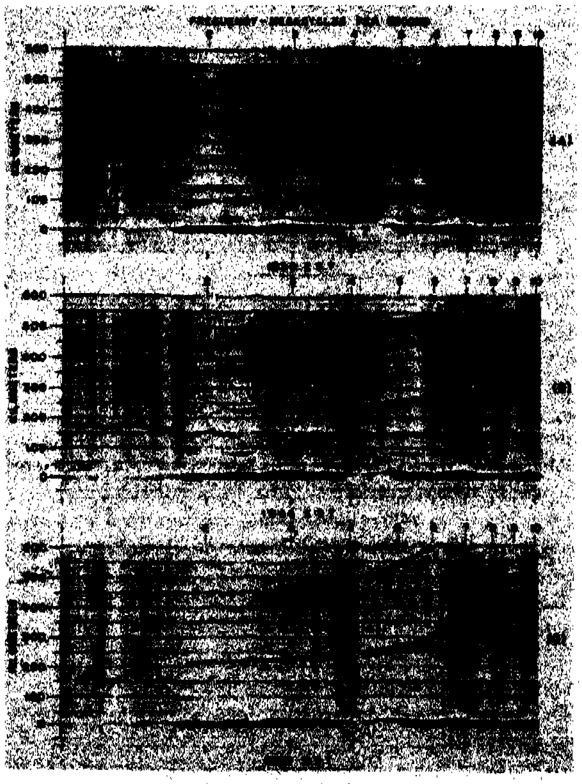

FIG. 3. Ionosphere recordings at Sterling, Virginia, Dec. 12, 1948, showing sporadic E reflections at 100 km, and reflection from meteor trail (in B) at 80 km. (Simulated reflections at 150 km caused by synchronous interference.)

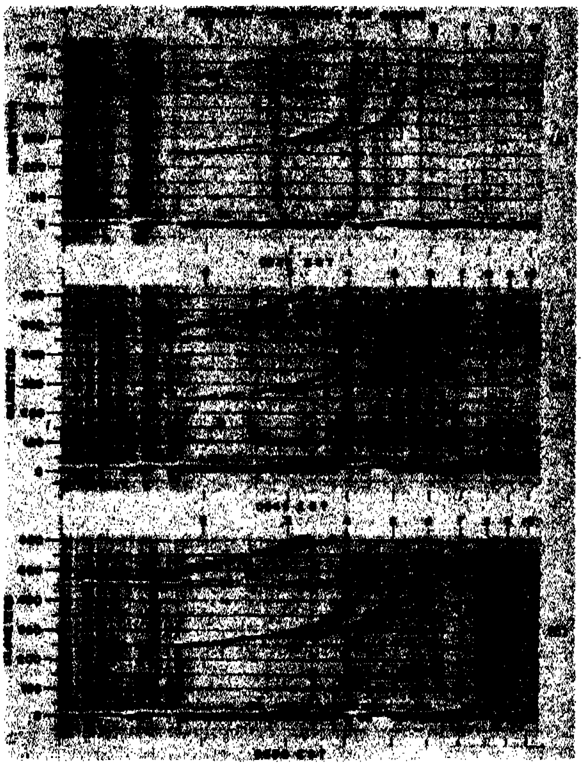

FIG. 4. Ionosphere recordings at Sterling, Virginia, Dec. 13, 1948, showing no sporadic E reflection but reflection from meteor trail (in B) at 105 km. (Simulated reflections at 470 km caused by synchronous interference.)

Fig. 4 is similar to Fig. 3 except that the records shown were made at a time when sporadic E was not present, and the meteoric reflection could be erroneously interpreted as a sporadic E reflection.

It has been found that the relative polarization of the antenna used with the ionosphere set and those used with the meteor equipment makes little or no difference at these frequencies. Coincidences of the type described occur when the orientation is such that the electric vectors are mutually perpendicular as often as when they are parallel.

Although it is beyond the scope of this note to go into an involved discussion of the relation of sporadic E reflections and meteoric ionization, it has been shown that reflections are obtained from meteoric ionization which can be distinguished from sporadic E reflections. A preliminary statistical examination, now under way, of a large quantity of data obtained over several months of nearly continuous observation does not appear to show that variations in meteoric activity are associated with corresponding variations in occurrence of sporadic E reflections. Continued observation of meteoric activity and perhaps a new line of approach in the technique of obtaining and evaluating the data are necessary before more extended conclusions can be drawn.

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Comments and Communications

The Betatron Building and Installation at the University of Saskatchewan

About two years ago the authors, all members of the staff of the Department of Physics at the University of Saskatchewan, felt that in order to carry out a significant research in nuclear physics they should act together as a team for the purpose of obtaining and using a 25-Mev betatron. The group was interested in investigating also its possible therapeutic uses in the treatment of cancer. Because of their wide interests they were able to enlist the generous support of the Atomic Energy Control Board of Canada in the purchase of the instrument and of the Provincial Government of Saskatchewan in the erection of the building to house it. Auxiliary equipment has been obtained through the support of the university, the National Research Council of Canada, the National Cancer Institute, and local cancer societies. The machine will be used both as an X-ray machine and as an electron beam machine. It is available to other groups in the university who may wish to investigate the biological and the chemical effects of high energy radiations.

The betatron building was built in one angle of the T of the main building but separated from it by 11 ft. It has the same floor level and is connected to the main building. The principal research rooms and instrument shop facilities of the main building are thereby made directly accessible to the betatron building, yet the betatron itself, a source of highly penetrating radiation, is well removed from persons in the main building. Its beam is directed away from the main building and is well below ground level.

The general plan of the betatron building, presented in Fig. 1, shows that the betatron room is surrounded by heavy concrete walls. The wall in the direct path of the X-ray beam is seven feet thick. In place of having a direct opening and a necessarily massive door between this room and the control room, entrance is made through a corridor long enough to reduce scattered radiation to a tolerable level. This corridor is entered from the control room through a doorway which is closed by a light, soundproof and airtight door. In spite of the greater walking distance between the control panel and the betatron room, experience has shown that this plan is very satisfactory.

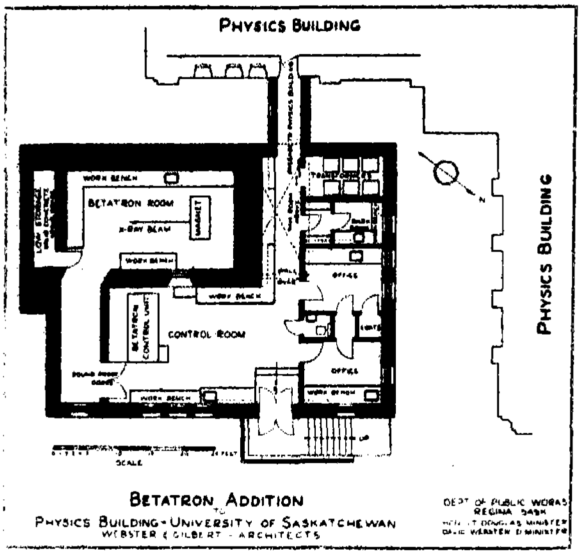

FIG. 1. General plan of the betatron building.

The betatron room is supplied with an overhead *I* beam with a chain block for lifting heavy equipment and moving it along a line normal to the front plane of the betatron and in line with the beam. Beneath this *I* beam are two steel rails on which a heavy truck with flanged wheels may be rolled. These rails and a closely adjacent steel scale of equal length are flush with the floor. Thus heavy equipment can be placed quickly at any point in front of the betatron and its position recorded. The work benches extending along each side and across the end of the room are fully equipped and have closed cupboards beneath them. The betatron itself rests on a concrete pier which extends 4 ft into the ground and is sufficiently distant from the rear wall to give room for the manipulation of air-pumping outfits which will be needed when donuts requiring continuous evacuation are used.

The control room contains, in addition to the usual laboratory benches, the large control unit. Between this room and the betatron room proper is a triple-glazed window, so placed that the operator at the control cabinet can see a large mirror mounted near the ceiling in the betatron room. This mirror can be rotated by the operator about either or both of two axes arranged so that he can constantly view the object or person being irradiated. Four large conduits inclined upwards at 45° from the betatron room make it possible to run experimental conductors from one side of the wall to the other without allowing any bundle of radiation to strike persons in the control room.

Four small rooms are provided. The transformer room is closed by a heavy fire- and sound-proof door. It contains three tripling transformers, three step-down transformers, and one 110-v service transformer. The photographic dark room is of the usual design. The remaining two rooms are similar and are equipped as small laboratories. However, should developments indicate the need, each with its small dressing room may serve as a reception room for patients. A washroom is included. Mention should be made also of a storage vault at the outer end of the betatron room, which utilizes space that otherwise would have been filled by concrete. Since the vault is entirely below ground level, 7 ft of concrete is not needed there for the absorption of radiation, as it is in the wall above.

As might be expected, the operation of the betatron results in the release of considerable heat energy. To remove this, a properly equipped fan room, not shown, is built over the hallway. Its blower discharges air into the airtight betatron room, forcing the air from that room through an acoustically-treated conduit into the control cabinet, which contains a large bank of condensers. From there it escapes either from the building or into the fan room to be recirculated, according to the outdoor temperature—an arrangement made necessary by the wide variations in temperature characteristic of our climate.

Fluorescent lighting is used throughout. All ceilings, the upper halves of the walls in the betatron room, and its entrance corridor are covered with Acousti-Celotex tile. A betatron usually has an objectionably loud hum, but it is found that the use of so much acoustical material and the L form of the room combine to reduce the noise level in the betatron room to 92 decibels. In the control room the hum is certainly not objectionable—its intensity there is only 54 decibels, a common level in offices. In the other rooms it is even lower.

TABLE 1

RADIATION RECEIVED DURING AN 8-HOUR DAY*

In line with the X-ray beam at ground level outside the building	0.02 r
Maximum observed on the roof of the building and above the axis of the X-ray beam	0.40 r
Near the door between the control room and the corridor leading to the betatron room:	
Control room side	0.06 r
Corridor side	0.25 r
In the corridor leading to the betatron room near the entrance to the betatron room proper	1.0 r
At the control panel in the control room	0.05 r
In the small laboratories	0.02 r
Directly behind the betatron in the hallway	0.10 r
In the dark room	0.05 r

* Betatron operating at 24 Mev and giving an output of 100 r/min at 3 ft.

The laboratory circuits distribute both a-c and d-c power, and include also storage battery lines. In the betatron room a special circuit makes it possible to block the operation of the betatron at three different points. A warning horn signal is automatically sounded 5 sec before voltage is applied to the magnet, thus giving any person working in the room ample time either to block the operation or to get out of the room. The uninsulated 16,000-v terminals on the back of the betatron are sufficiently dangerous to warrant these precautions. The corridor offers an easy and quick escape from radiation which would not have been possible had a heavy door been used instead.

Stray radiation at various points was measured by a Victoreen radiation meter, both inside and outside the building, and the results are recorded in Table 1.

It will be seen that the building affords adequate protection to everyone having to do with the betatron. When it is realized that the betatron will seldom, if ever, be operated continually for an 8-hr day the actual radiation likely to be received by any person is considerably smaller that that indicated in Table 1. The background count of a counter inside a lead castle situation in the main physics building is not affected by the operation of the betatron, although the background inside the betatron building is affected.

The betatron was manufactured by Allis-Chalmers Company of Milwaukee, Wisconsin, under the direction of Dane Scag. The machine is very similar to the one being used by the betatron group under D. W. Kerst at the University of Illinois. The machine is provided with four elevator screws simultaneously operated by a single motor to raise the upper yoke of the magnet. This greatly facilitates the replacement of donuts. The poles of the magnet are made of oriented steel and the field is adjusted for azimuthal uniformity by package coils. The machine is provided with a monitor which records the instantaneous intensity of radiation with auxiliary circuits to integrate this intensity. After a prearranged dose in roentgens has been given the machine automatically shuts itself off. The condensers for the tuning of the betatron are all located in the control unit.

The betatron, as installed, could operate only at an energy of about 25 Mev but it is being altered to operate through a range of energy levels below this value. An integrator circuit is being constructed to maintain any energy setting of the betatron to an accuracy of 0.1 percent. This will be accomplished by causing expansion of the electronic orbit to occur when the magnetic flux reaches a predetermined value. The machine will then operate at this energy or flux regardless of line voltage fluctuations or frequency changes. For constant voltage input to the betatron building, the magnetic flux is constant to within ± 2 percent as the frequency varies from 59.7 to 60.3 cycles per second.

The group working with the betatron plans to do experimental work in the field of nuclear physics. Some of the problems which will be attacked first include the measurement of the threshold energy for photodisintegration for (γ, p) and (γ, n) reactions in which the product of the reaction is not radioactive. This means that it will be necessary to detect the protons or neutrons produced in the reaction. Other problems involve the measurement of the energy distribution in the betatron spectrum so that the actual cross sections for photodisintegration may be measured.

For the investigation of the therapeutic applications of the betatron a d-c amplifier in conjunction with a small probe ionization chamber has been constructed. This will be used to measure the distribution of radiation within a water phantom. This distribution will be measured for a series of sizes of fields and for different types of step filters in an effort to get a clinically useful distribution. After this has been accomplished the machine may be used for cancer therapy. Many interesting experiments using the electron beam have been tentatively planned. These, however, must await the successful development of pumping techniques for use with electron donuts which have been obtained from the University of Illinois.

The authors would like to take this opportunity to thank those who have helped them to obtain the betatron and its building and auxiliary equipment in such a short time. In particular they wish to express their appreciation to D. W. Kerst and his associates, of the University of Illinois, who made available to them the facilities of their laboratory and who gave generously much valuable information and advice.

E. L. HARRINGTON, R. N. H. HASLAM,
H. E. JOHNS, and L. KATZ
University of Saskatchewan

Note on the Origin of Cosmic Rays[1]

W. Baade and F. Zwicky (*Phys. Rev.*, 1934, **45**, 138 and **46**, 76), F. Cernuschi (*Phys. Rev.*, 1939, **56**, 120), and F. Hoyle (*Monthly Notices R.A.S.*, 1946, **106**, 384) have suggested that supernovae might be responsible for cosmic rays. Hoyle has recently considered this idea more closely in connection with his ideas about the origin of the chemical elements (*ibid.*, p. 343). He suggests that the heavy nuclei, or, better, the nuclear lumps, which are expelled during the supernova outburst might lose their accompanying electrons and thus become surrounded by strong electric fields in which nuclei might be accelerated up to energies as high as the largest energies found in cosmic rays. As a point in favor of this theory, Hoyle points out that, assuming that the average supernova will produce 0.1 M_0c^2 (M_0: solar mass; c: the velocity of light) energy in the form of cosmic rays, the density of extragalactic nebulae and the frequency of supernova outbursts are such that one can just explain the observed density of cosmic rays observed on the earth.

However, H. Alfvén (*Z. Physik*, 1937, **107**, 579) has pointed out that a galactic magnetic field of only 10^{-13} gauss would be sufficient to keep all cosmic rays inside our galaxy, and L. Spitzer, Jr. (*Phys. Rev.*, 1946, **70**, 777) has given strong arguments for the existence of such a galactic field. This means that we have to consider only our own galaxy as far as the production of cosmic rays is concerned. If we again assume that supernova outbursts are responsible for cosmic rays, we now have to estimate how large a density of cosmic rays we can expect. Assuming the production of cosmic ray energy per supernova to be about 0.001 M_0c^2 (Hoyle's estimate seems to us to be rather high, and we shall see that even a ten times smaller estimate would have been sufficient in order to get agreement between the observed and estimated energy densities), and assuming one supernova outburst per 500 years per galaxy (Zwicky, F. *Astrophys. J.*, 1942, 96, 28), the energy produced per sec per galaxy is about 10^{41} erg. According to R. D. Richtmyer and E. Teller (*Phys. Rev.*, 1949, 75, 1729), the lifetime of a cosmic ray in our galaxy is about 50 million years. Assuming the volume of our galaxy to be about 10^{12} cubic parsec ($\sim 3.10^{67}$ cm^3), the total cosmic ray density in our galaxy should be about 10^{-11} erg cm^{-3}. This is of the same order of magnitude as the value of about 5.10^{-12} erg cm^{-3} obtained by Richtmyer and Teller from B. Rossi's data (*Rev. mod. Phys.*, 1948, 20, 537.).

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[1] This letter was written while the author was temporarily at Yerkes Observatory, Williams Bay, Wisconsin.

As far as the production of the high energy particles in the supernova outburst is concerned, we favor a mechanism different from that suggested by Hoyle, but essentially the same as that proposed by Cernuschi. Cernuschi proposed the fission of the nuclear lumps as the mechanism and made some estimates of the available energy per fission fragment on the basis of a very crude model of the nucleus. At present, we have a better understanding and knowledge of the energy which can be released in a fission process of a nuclear lump. Also it seems to us that the primary cosmic rays should not be the fission fragments but the neutrons accompanying the fission. For an estimate of the energy which becomes available at a fission process, we shall use N. Bohr and J. A. Wheeler's expression (*Phys. Rev.*, 1939, 56, 426) for the packing constant (i.e., the energy content per unit mass)[2] of a nucleus of charge Z and atomic weight A in the form given by G. B. van Albada (*Astrophys. J.*, 1947, 105, 393):

$$f = \alpha y^2 + \beta y - \gamma + kZ^2A^{-4/3} + sA^{-1/3}, \tag{1}$$

where f is the packing constant and

$$\left.\begin{aligned} y &= (\tfrac{1}{2}A - Z)/A,\ k = 0.63\ mMU,\ s = 15\ mMU \\ \alpha &= 83\ mMU,\ \beta = 0.81\ mMU,\ \gamma = 6.65\ mMU. \end{aligned}\right\} \tag{2}$$

From van Albada's considerations of equilibria at zero temperature and high densities, it follows that the specific charge of the nuclear lumps ejected by the supernova will be in the neighborhood of 1/4:

$$Z/A \sim 1/4. \tag{3}$$

Using equations (2) and (3), equation (1) takes the form:

$$f = -1.3 + 0.04\,A^{2/3} + 15\,A^{1/3}\ mMU \tag{4}$$

and the energy content of the nuclear lump is given by:

$$E = Af = -1.3\,A + 0.04\,A^{5/3} + 15\,A^{2/3}\ mMU \tag{5}$$

In Table 1 we have collected the values of f in mMU, and E in mMU and in ev for different values of A.

It is immediately seen from Table 1 that the fission of nuclear lumps with A equal to or larger than 10^5 will produce energies of the order of the highest observed cosmic ray energies.

The present note must not be taken too seriously, but there are a few points that might be well worth looking into. The first one is the fact that the primary cosmic rays contain about 30% nuclei with Z between 2 and 26 (see, e.g., Bradt, H. L., and Peters, B. *Phys. Rev.*, 1948, 74, 1828 and 1949, 76, 156). This can partly be due to the ejection of these nuclei with energies of the order of magnitude of their rest energy by the supernova during the outbrust (cf. Hoyle, *Monthly Notices R.A.S.*, 1946, 106, 384), or partly due to possible tripartitions. Experiments with uranium (Tsien, S. T. *et al.* *J. Phys. Rad*, 1947, 8, 165 and 200; see also Titterton, E. W., and Goward, F. K. *Phys. Rev.*, 1949, 76, 142, and Lark-Horovitz, K., and Schreiber, R. E. *Phys. Rev.*, 1941, 60, No. 2, 156) indicate that one tripartition occurs against about 200 to 400 ordinary fission processes. It might be interesting to investigate theoretically whether the highly unstable nuclear lumps would favor a larger percentage of tripartitions, and how the distribution of the fission products (especially the light one) over the various Z values would be.

TABLE 1

A	f in mMU	E in mMU	E in ev
100	2.9	300	$3 \cdot 10^8$
200	2.7	500	$5 \cdot 10^8$
300	2.8	800	$8 \cdot 10^8$
500	3.2	1,600	$2 \cdot 10^9$
1,000	4.2	4,000	$4 \cdot 10^9$
5,000	12	$6 \cdot 10^4$	$5 \cdot 10^{10}$
10,000	18	$2 \cdot 10^5$	$2 \cdot 10^{11}$
100,000	85	10^7	10^{13}
1,000,000	400	$4 \cdot 10^8$	$4 \cdot 10^{14}$
10,000,000	2,000	$2 \cdot 10^{10}$	$2 \cdot 10^{16}$

A second point is whether it is possible to understand from the supernova picture of production of cosmic rays that the cosmic ray spectrum behaves like E^{-3}. In order to investigate this it would be necessary (a) to have a quantitative picture of the supernova outburst, which also would give a test for the validity of the equilibrium theory of the chemical elements (see, e.g., ter Haar, D. *Amer. J. Phys.*, 1949, 17, 282 and *Cosmogonical problems and stellar energy*, to be published); and (b) to have a quantitative statistical picture of the fission of nuclear lumps. The aging process discussed by E. Fermi (*Phys. Rev.*, 1949, 75, 1169) in his paper on the origin of the cosmic rays has certainly also to be taken into account. Indeed, it may well be that, as in so many other instances, a more acceptable theory will only be formed when ideas from all the different papers will have been melded togethed into one large compromise.

I should like to express my thanks to Dr. K. Lark-Horovitz for a discussion on the subject of this paper.

D. TER HAAR

Purdue University

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[2] Reference in the text as mMU (milli mass units).

NEWS and Notes

Paul B. Pearson, former head of the Department of Biochemistry and Nutrition and dean of the Graduate School of Texas Agricultural and Mechanical College, has been appointed acting chief of the Biology Branch, Biology and Medicine Division of the Atomic Energy Commission. Dr. Pearson succeeds **James H. Jensen,** who has been on leave of absence from North Carolina State College and will return there as director of the Plant Pathology Division.

John M. Stalnaker, professor of psychology and former dean of students at Stanford University, has been named professor of psychology and coordinator of psychological sciences and services at Illinois Institute of Technology.

Robert F. Pitts, professor of physiology and director of the physiology laboratory at the Syracuse University Medical School since 1946, will return to the Cornell University Medical College faculty as head of the Department of Physiology and Biophysics and professor of physiology. Dr. Pitts was a staff member of Cornell Medical College from 1942 to 1946.

William F. Hester, former director of insecticide and fungicide research of the Rohm and Haas Company in Philadelphia, has been named administrator of the fellowships of Koppers Company, Inc., at the Mellon Institute. Dr. Hester will direct the work of the 98 scientists and their aides engaged in research and development work on the 13 fellowships.

A. C. Leopold, former research physiologist at the Hawaii Pineapple Company, Honolulu, has joined the staff of the Horticulture Department of Purdue University. Dr. Leopold will direct research on the flowering and nutrition of greenhouse plants.

Alfred G. Susie, chief chemist at Marbon Corporation, Gary, Indiana, has been appointed supervisor of plastics research at Armour Research Foundation of Illinois Institute of Technology. Dr. Susie will be in charge of research projects dealing with plastics in the chemistry and chemical engineering department of the foundation.

Ray Pepinsky, Alabama Polytechnic Institute, has been appointed research professor of physics at Pennsylvania State College. Dr. Pepinsky will be director of the X-Ray and Crystallography Laboratory, where he will make use of the electronic computer which he developed under contract with the Office of Naval Research.

Visitors to U. S.

Paul Rivet, director of the Musé de l'Homme, Paris, and **Claude Lévi-Strauss,** French anthropologist, were honor guests at a reception given for the members of the 29th International Congress of Americanists on September 9 in New York City.

Antonio Goubaud Carrera, of the National Indianist Institute, Guatemala City, was one of the principal speakers at the conference on Middle American Ethnology and Social Anthropology, held in New York City, September 5–12, in conjunction with the 29th International Congress of Americanists.

Visitors at the National Bureau of Standards during the week of August 29 included **D. de Klerk, K. W. Taconis,** and **C. J. Gorter,** of the University of Leiden, Holland; **G. C. Ellis,** metallurgist with the Armament Research Establishment of the Woolwich Arsenal, London, England; **N. Kurti** of the Clarendon Laboratory, Oxford, England; **Benjamin Mantel M.,** chemical engineer with the Public Works Department, Havana, Cuba; **C. Nanjudayya,** research officer, Technological Laboratory, Indian Central Cotton Committee, Bombay, India; **A. van Itterbeek,** director, Low Temperature Laboratory, University of Louvain, Belgium; and **Fredrik Dahlgren,** head of the Electrical Engineering Department, Royal Polytechnic Institute, Stockholm, Sweden.

Grants and Awards

The John Simon Guggenheim Memorial Foundation has awarded 22 Latin American fellowships, totaling $70,000, to assist Latin Americans in carrying on research and creative work in the U. S. Fields of investigation in which scientists were honored include medicine, zoology, paleontology, botany, and mathematics. The foundation awards are the twentieth in its annual series of inter-American fellowships. Last April the foundation granted 144 fellowships to citizens and permanent residents of the U. S. and Canada.

At a special convocation held on the 200th anniversary of the birthday of Goethe, the **University of Frankfurt** conferred honorary degrees on the following scientists: M.D. degree—Franz Bluntschli, professor of anatomy at the University of Bern, and Paul Weiss, professor of zoology at the University of Chicago; Ph.D. degree—Otto Hahn, professor of physics at the University of Goettingen and director of Max Planck Gesellschaft, and Ferdinand Blum, former collaborator of Paul Ehrlich.

The John Price Wetherill Medal of the Franklin Institute of the State of Pennsylvania has been awarded to Edgar Collins Bain, vice president in charge of research and technology at the Carnegie Illinois Steel Company. Dr. Bain has been honored for his research in the structure of metallic alloys and the application of the isothermal method to the study of the rates of transformation in steel.

The new $1,000 Precision Scientific Company Award in Petroleum Chemistry will be granted to Bruce H. Sage, professor of chemical engineering at the California Institute of Technology. Dr. Sage, who is also associate director of engineering and head of the explosives department at the Naval Ordnance Test Station, Inyokern, California, will receive the prize at the national meeting of the American Chemical

Society in Atlantic City, New Jersey, on September 19. The society's **$1,000 Award in Pure Chemistry** will be presented at the same time to Richard T. Arnold, professor of organic chemistry at the University of Minnesota. Dr. Arnold will be honored for his work in the mechanisms of reactions and the nature of aromatic nuclei.

The Frederick Ives Medal of the Optical Society of America has been awarded to George R. Harrison, dean of science at Massachusetts Institute of Technology. The medal will be presented at the annual meeting of the society at Buffalo in October.

The Elmer Hess Prize of the Northeastern Section of the American Urological Association has been presented to Howard T. Thompson, Buswell Fellow in the Department of Surgery of the University of Rochester School of Medicine and Dentistry, for his report on animal experiments in cancer of the bladder.

Meetings and Elections

An important discussion of legislative matters affecting science and scientists took place on Aug. 24, at the Marine Biological Laboratory, Woods Hole, Massachusetts. Howard A. Meyerhoff, Executive Secretary of the AAAS, led a meeting on the National Science Foundation and on the problems raised by the loyalty investigations of scientists.

The Report of the AAAS Special Committee on Civil Liberties of Scientists, recently approved by the AAAS Council, was summarized. Its conclusions (*Science*, Aug. 19, 1949, pp. 177–9) strongly condemn the application of security clearance and the Loyalty Order to others than those working in military research. The linkage of the problem of federal support of science and the current hysteria on clearance and loyalty was emphasized in the discussion. Scientists generally recognize that effective development of science through federal support is being threatened by the indignity and insecurity to which scientists are exposed by investigations which probe thoughts and private lives rather than specific deeds.

Detlev W. Bronk, chairman of the National Research Council, stated that the NRC is unequivocally opposed to application of clearance procedures to any scientist not working on classified projects, but will continue administering funds because some 50 present fellows, whose grants are to be renewed on October 1, might otherwise be unable to continue. According to Dr. Bronk, the failure of individual scientists and of scientific bodies to take a firm, public stand on so vital a matter of scientific and national policy already has weakened the position of the NRC.

The ensuing discussion emphasized the need for scientists and scientific organizations to become acquainted with what is happening and to take prompt and decisive action to stop the indiscriminate extension of security regulations so fatal to the free development of science. Over 100 scientists at Woods Hole affixed their names to an endorsement of the AAAS report within a few days after the discussion.

The question was also raised whether the NRC, if it were to accept administration of funds under security restrictions to individual and scientific freedom, would endanger for the sake of some 50 present AEC fellows, the long-term welfare of the nation's science. The point was raised that a flat refusal by the NRC to administer such funds might actually lead Congress to remove the restrictions rather than to abandon the fellowship program.

Dr. Bronk stated that the NRC needs the support of the body of American scientists. To obtain such support, it was proposed by participants at the meeting, (1) That the NRC institute a poll of all scientists, asking an expression of opinion regarding administration of funds where restrictions on education are involved. This poll could be held expeditiously by allocating a page in *Science* to the question with a returnable answer form. (2) That the Council inform the present AEC fellows of its opposition, on principle, to the blanket requirements of clearance; that its decision to continue administering the present fellowships is based on its unwillingness to jeopardize the stipends; and that it will not administer the fellowships unless a majority of the fellows so desire. The council should further pledge that if present fellows wish to seek stipends or positions elsewhere, it will assist them.

A suggestion to provide emergency stipends for those AEC fellows who elect not to accept renewals under the restrictions and who cannot immediately get other fellowships or positions was made. To provide for the latter, a campaign should be launched among scientists and scientific societies for a special emergency fund to which individual scientists would each pledge $5 or more. These suggested actions would demonstrate to the Congress and to the public that scientists feel strongly about the rising tide of restrictions which threaten the future of the nation's science and its welfare. That scientists are reacting to these threats is made evident by three communications appearing simultaneously in the August 19 issue of this journal. They are: (1) The report of the AAAS Committee, (2) the condemnation of the O'Mahoney rider by the AEC General Advisory Committee, and (3) a letter from Marshall Stone explaining his resignation from the NRC Committee on Post-Doctoral AEC Fellowships.

ROBERT CHAMBERS
HARRY GRUNDFEST
ROBERT HODES

A symposium on large-scale digital calculating machinery will be held September 13–16 at Harvard University under the joint sponsorship of the university and the U. S. Navy Bureau of Ordnance. The purpose of the meeting is to consider use of the machines for solving problems in the social sciences, physiology, and psychology. These problems will be discussed at the final session of the meeting by specialists in the human and social sciences. Other sessions, which will be attended by scientists, government officials, and businessmen, will cover the entire field of these machines.

A symposium on brucellosis will be held September 22–23, under the joint sponsorship of the National Institute of Health, Bureau of Animal Industry, and National Research Council. Twenty-four papers will be presented at the five sessions to be held in Wilson Hall, Administration Building, National Institutes of Health, Bethesda, Maryland. Morning sessions will begin at 9:30, afternoon sessions at 1:30, and the evening session, September 22, at 8:00. Printed programs will be available in advance of the meeting. C. L. Larson, of the institutes' Laboratory of Infectious Diseases, and C. K. Mingle, of the Department of Agriculture's Tuberculosis and Brucellosis Eradication Division, are in charge of the program. Preliminary plans have been made to publish the papers in a new symposium series sponsored by the AAAS and the National Institutes of Health.

The Society of Rheology will hold its 20th Annual Meeting in New York City on November 4–5, at the Hotel New Yorker. Eighteen papers on the flow and deformation of matter will be presented. Non-members are invited to attend. Programs may be obtained in advance of the meeting by writing to Earl K. Fischer, Secretary-Treasurer, 107 Washington Avenue, Charlottesville, Virginia.

The American Society for Pharmacology and Experimental Therapeutics will hold its first interim meeting in Indianapolis, November 17–19. The scientific sessions will be held at the Indiana University Medical Center.

The Roscoe B. Jackson Memorial Laboratory has appointed Leslie C. Dunn, head of the Genetics Department of Columbia University, as president of its new board of scientific directors. James B. Murphy, head of the Cancer Research Department of the Rockefeller Institute, was chosen vice president. Members of the board include Clarence C. Little, director of the laboratory; Frank Beach, professor of psychology at Yale University; Homer Smith, professor of physiology at New York University; Merle Tuve, physics professor at Johns Hopkins University; Edwin B. Wilson, vice president of the National Academy of Sciences; and Sewall Wright, professor of genetics at the University of Chicago.

Deaths

Percy Edward Newberry, 80, Egyptologist, died August 7 at his home in Surrey, England. Professor Newberry was professor of ancient Egyptian history and archaeology at Cairo University from 1929 to 1933, and a former president of the Anthropological Section of the British Association for the Advancement of Science.

Walter A. Hynes, 52, president of the Metropolitan Microchemical Society and professor of analytical chemistry at Fordham University, died of a heart attack August 21 at St. Joseph's Hospital, Yonkers, New York.

Sir Frederick William Moore, 91, Irish botanist, died in Dublin August 24. Sir Frederick was a former president of the Royal Zoological Society of Ireland, and Keeper of the Royal Botanic Gardens, Glasnevin, Dublin, from 1879 to 1922.

Edwin B. Powers, 69, head of the University of Tennessee Department of Zoology for 25 years, died August 26 at Knoxville. Dr. Powers was an expert on salmon migration and fish physiology.

Boris Krichesky, 45, associate professor and chairman of the Department of Zoology, University of California, died of a heart attack on August 28th while vacationing in Oregon. Dr. Krichesky contributed extensively to the field of endocrinology.

A survey of medical and hospital care has been initiated by Brookings Institution. The project is the first to attempt to include all sources of health services and facilities. It is estimated that the study will be completed in two years by a full-time staff of eight, with the participation of specialists in various fields who will be called in as consultants. The cooperation of national professional societies, labor organizations, insurance companies, governmental agencies (federal, state, and local), industrial health organizations, farm groups, and other groups is being solicited.

Present plans call for publication of findings in two volumes: the first, a comprehensive and statistical report which will make available data on the extent of medical care and provisions for meeting the cost through insurance or prepayment plans, or through public services or private philanthropy; the second, based upon facts presented in Volume I, would evaluate the plans now in operation and those proposed.

The American Society of Human Genetics, which was organized about a year ago, will start to publish in October a journal pertaining to research in human genetics. The publication is called *The American Journal of Human Genetics*, and will be edited by C. W. Cotterman, Heredity Clinic, University of Michigan, Ann Arbor. Manuscripts for consideration should be sent to Dr. Cotterman. The journal will appear in annual volumes of four issues each at $8.00 per volume. Subscriptions should be addressed to the secretary of the society, Herluf H. Strandskov, Department of Zoology, University of Chicago, Chicago 37.

The National Bureau of Standards announces the following recent additions to the series of 169 compounds now available as standard samples of hydrocarbons for calibrating analytical instruments and apparatus in the research, development, and analytical laboratories of the petroleum, rubber, chemical, and allied industries: n-tridecane, cis-2-hexene, 4,4-dimethyl-trans-2-pentene, 1,2,3,5-tetramethylbenzene, 1-methyl-4-tert-butylbenzene, naphthalene, and 2-methylnaphthalene. A complete list of samples may be obtained from the National Bureau of Standards, Washington 25, D. C.

The National Geographic Society will sponsor a field survey of the scarlet ibis in the hinterlands of Venezuela. Paul A. Zahl, biologist and ornithologist of New York City, will direct the expedition, which will study the nesting practices, habitat, and migration of the scarlet ibis and other bird life of the area. Dr. Zahl hopes to locate colonies of the scarlet ibis in rookeries deep in the flooded llanos of Venezuela's State of Apure, which can be reached only by small boat or horseback. The birds are reported to have sought refuge with herons, other ibis varieties, and possibly spoonbills.

Dr. Zahl will make his headquarters in San Fernando, where he will be joined by native helpers. The government of Venezuela will cooperate with him to further the work of the project. The expedition will be assisted by William Phelps, resident associate in Caracas of the American Museum of Natural History.

The new system of electrical measurement using absolute units, adopted by the International Conference of Weights and Measures and officially instituted January 1, 1948, is described in a new booklet, Circular C475, ***Establishment and Maintenance of the Electrical Units,*** published by the National Bureau of Standards and available at 25 cents a copy from the U. S. Government Printing Office, Washington 25, D. C. The booklet gives an account of the working, history, and maintenance of the international system of electrical units. Also described are the methods used in the measurements that now form the basis for the absolute units, in which all certifications for standards and instruments are given by the National Bureau of Standards.

The Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, lists the following wanted chemicals: 1,4-dihydropyrazine-2,3-dione, 1,2-dihydropyridazine-3,4-dione, 1,2-dihydropyridazine-3,6-dione, *l*-mannose, *l*-galactose, naringenin, 2-methyl-3-hydroxy-γ-pyrone, phosphorylthiocholine, phosphorylcholine, coniferyl aldehyde, imperatorin, 6-ketoprogesterone, 2-methyl-5-hydroxypropiophenone, 2-methyl-3-nitropropiophenone, 2-methyl-5-aminopropiophenone, sulfanylthiourea, phloretin, cyclobutane, cyanogen, and 2-thio-4-aminopyrimidine.

Make Plans for—

American Society of Photogrammetry, regional meeting, October 3–4, Denver, Colorado.

American Dietetic Association, 32nd annual meeting, October 11–14, Denver, Colorado.

American Association of Petroleum Geologists, October 12–15, Biloxi, Mississippi.

American Dental Association, October 17–21, San Francisco.

Symposium on small angle X-ray scattering, October 21–22, University of Missouri, Columbia.

National Academy of Sciences, autumn meeting, October 24–26, University of Rochester, New York.

Optical Society of America, 34th annual meeting, October 27–29, Hotel Statler, Buffalo, New York.

Recently Received—

Journal of the Council for Scientific and Industrial Research, Commonwealth of Australia. (Quarterly publication.) Direct inquiries to J. J. Gourley, Govt. Printer, Melbourne, Australia.

Study of the Interrelationships of Psychological and Physiological Measures on Submarine Enlisted Candidates by Ellsworth B. Cook and Robert J. Wherry. Issued by Medical Research Laboratory, U. S. Naval Submarine Base, New London, Conn.

Cochise and Mogollon Sites, Pine Lawn Valley, Western New Mexico, by Paul S. Martin, John B. Rinaldo, and Ernst Antevs. (Fieldiana: Anthropology, Vol. 38, No. 1.) Issued by Chicago Natural History Museum, Chicago, Ill. $3.50.

Table of Sines and Cosines to Fifteen Decimal Places at Hundredths of a Degree. (National Bureau of Standards, Applied Mathematics Series No. 5, 1949.) Available from Supt. of Documents, U. S. Govt. Prntng. Office, Washington 25, D. C. at 40 cents.

El Aliso (series of papers on the native plants of California), Vol. 2, #1, including "A Long Term Test of Seed Longevity." Rancho Santa Ana Botanic Garden, Route 3, Anaheim, Calif. $5.00 per volume.

List of Scientific Papers Published in the Middle-East, May 1949 issue. Unesco, Science Cooperation Office—Middle-East, Cairo, Egypt.

The Terena and the Caduveo of Southern Mato Grosso, Brazil by Kalervo Oberg. (Smithsonian Institution, Institute of Social Anthropology, Publ. No. 9, 1949.) Order from Supt. of Documents, U. S. Govt. Prntng. Office, Washington 25, D. C. Price 60 cents.

Guide to the Collection of Rocks in the British Museum. (2nd ed.) Order from British Museum (Natural History), London, S. W. 7. One shilling.

Third Annual Report of the South African Council for Scientific and Industrial Research. Printed by Cape Times, Ltd., Cape Town, South Africa.

The deadline for the receipt of nominations by fellows of the AAAS for the **Theobald Smith Award in Medical Sciences,** established in 1936 by Eli Lilly and Company, has been extended to *October 30.* For the conditions of this annual award, which consists of $1,000, a bronze medal, and travel expenses up to $150, see *Science,* July 15, p. 80. Nominations should be sent to Dr. Gordon K. Moe, secretary of Section N, Medical School, University of Michigan, during September, and to Dr. Malcolm H. Soule, chairman of the Award Committee, same address, during October.

Entries in the **Annual International Photography-in-Science Salon,** sponsored jointly by *The Scientific Monthly* and the Smithsonian Institution, will be accepted by the Editor, *The Scientific Monthly,* 1515 Massachusetts Ave, N.W., Washington 5, D. C., up to the date of judging, *September 26, 1949.*

Structure and Dynamics of the Thunderstorm

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University of Chicago

MANY TEXTBOOKS OF METEOROLOGY AND PHYSICS contain diagrammatic representations of the structure and vertical circulation of a thunderstorm. They are based mainly on theoretical deductions as to the kind of thermodynamic engine the authors, from laboratory experience, think the thunderstorm should be. Until recently, no precise means of probing the storms to verify or modify the textbook picture was available. Numerous exploratory airplane flights into more or less violent convective clouds or storms had been made, but until the development of the uses of radar, it was impossible to tell where the aircraft were with respect to the storm at any given moment. Free meteorological balloons also had ascended haphazardly into thunderstorms, but again it was not possible to track them until the perfection of radio-direction finding.

Meteorologists knew there were things wrong with the textbook interpretation of the thunderstorm, so with the wartime development of radar and improvements in the art of blind flying, plans were made for a concentrated research program to find out what goes on inside the thunderstorm. Commercial and military aviation interests needed the knowledge for flight safety and all-weather flying programs. With the support of all the interested agencies, the U. S. Weather Bureau organized an intensive campaign of observation and measurement. The undertaking, which came to be known as the Thunderstorm Project, developed into the largest program ever directed at a single atmospheric phenomenon and became a joint project of the U. S. Air Force, the U. S. Navy, the National Advisory Committee for Aeronautics, and the U. S. Weather Bureau.

In the summer of 1946 the observations were carried out in Florida, then in the summer of 1947 a similar program was completed in Ohio. Since that time the analysis of the large amount of data collected has been performed by a group of government and other meteorologists at the University of Chicago, and a comprehensive report of the findings is now in press. It offers solutions of the problems of thunderstorm structure and dynamics which have puzzled meteorologists for years and contains much information of use in flight operations.

In the following paragraphs will be given a brief description of the project and a summary of some of the results.

System of Observations

Basically, the observation program was designed to obtain a complete description of the thunderstorm and to measure its intensity. The turbulence or bumpiness and the broad up-and-down motions of the air were considered the most important items to be investigated, but great stress also was laid on all measurable quantities that could give a clue to the vertical and horizontal air circulations and to the heat exchanges that drive these circulations and produce the rain. Lightning, which has been one of the main subjects of interest in many years of investigation by physicists and meteorologists, was considered to be of secondary importance, although arrangements were made for measurements of the cloud electricity.

In its main details the observation system consisted of the following:

1. Airplanes were used as probes to measure turbulence, updrafts and downdrafts, temperature, and electrical field, and to obtain visual data such as hydrometeors, cloud extent, etc. Northrup Black Widow night fighters (P-61's) were utilized, flown by some of the Air Force's most expert instrument pilots, who volunteered for the task. In a normal mission, five airplanes made simultaneous traverses through the thunderstorms at five different levels, namely, 5000 ft, 10,000 ft, 15,000 ft, 20,000 ft and 25,000 ft.

2. A surface micronetwork was established, consisting of 55 stations located one mile apart in Florida and two miles apart in Ohio. The stations were equipped with gust-recording anemometers and wind vanes, hygrothermograph, weighing rain gage and barograph. The clock speeds on these instruments were fast enough to permit a time resolution to nearly a minute in most cases. The stations were attended daily by observers who traveled through the network in jeeps.

3. In and around the surface micronetwork were set up six radiosonde balloon stations with radio-direction-finding equipment. Outside the network were four radar wind-finding stations, using small radar-

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[1] The author directed the government's Thunderstorm Project, which was completed this summer.

target-bearing balloons. All these stations made simultaneous balloon releases from which could be obtained, in addition to temperature and humidity data, detailed information concerning the perturbed horizontal wind flow, especially the horizontal inflow and outflow, of the cumulonimbus cloud.

4. Long range radar was used to detect the development of thunderstorms, to select the storms for study, and to guide the pilots and the balloon releases. The airplanes carried transponder beacons by means of which they could be identified separately and traced on the radar 'scopes even when inside the cloud echoes. The pilots were vectored through the storms by the flight controller who, stationed at the ground radar 'scopes, could watch their movements in relation to the thunderclouds. Radar also was used to study the development, growth, movement, distribution, and dissipation of thunderstorms. In this connection, range-height-indicating radar was also employed, giving a vertical crosssection through the clouds and affording an opportunity to study the rates of vertical growth. All 'scopes were photographed every few seconds.

5. Time synchronization afforded the means by which all observations from airplanes, surface, balloon recordings, and radar could be tied together to give the instantaneous and progressive picture of the atmospheric processes.

STRUCTURE AND LIFE CYCLE

In the analysis of the airplane data it soon became apparent that in the usual large thunderstorm the pilot was encountering areas of strong turbulence, each surrounded by a narrow belt of smooth but cloud-filled air. Roscoe R. Braham, Jr., Thunderstorm Project analyst assigned to this problem, recognized these as distinct convection cells that had become more or less joined together or developed as appendages to an original "mother" cell. For example, a typical Florida thunderstorm that was studied was found to be 20 miles long and about 5 to 8 miles wide, and to have six recognizable cells within it. These were roughly oblong areas measuring 3 to 7 miles across. Between each cell the airplane, although still in heavy cloud, recorded a smooth portion having a width of about a mile or less.

An examination of the photographs of radar echoes returned by the thunderstorms through their life histories verfied the cellular structure by showing the fusion or growth of these cells occurring in much the same way as the growth of masses of certain kinds of bacteria. Where the cells were present over the surface micronetwork, they could also be identified in the rainfall pattern which, at any given moment, had a distribution corresponding to that of the cells. A separate rain maximum would appear under each cell. Other meteorological elements were found to fit the cellular pattern.

The cells were not all alike in structure. Some were found to consist of an updraft only; some had both updraft and downdraft, while others contained only a downdraft. These differences were found to be associated with different stages in the development and dissipation of the cells. From these studies, the life cycle of the thunderstorm cell was worked out, and it was immediately apparent that a thunderstorm usually contains cells in different stages of the life cycle. While every storm must be one-celled at the beginning, the simple unicellular type was found to be rare because its period as a solitary cell lasts only a few minutes after it has reached rainy, thundery conditions. Thus the textbook diagram of a thunderstorm, always unicellular, is misleading.

The life cycle of the cell naturally divides itself into three stages: the *cumulus stage*, the *mature stage*, and the *dissipating stage*.

CUMULUS STAGE

The first stage of the thunderstorm cell is the cumulus cloud, although only a few cumuli actually build into thunderstorm cells. During this stage two or three cumulus clouds may grow together into one cell, whose diameter may be between one mile and five miles, and whose top usually does not initially exceed 15,000 feet.

The most important structural feature of the cumulus stage is the updraft prevailing throughout the entire cell, balanced by slow settling in the environment. As might be expected, the temperatures in appreciable updrafts are higher than in the environment at corresponding levels. The general updraft varies from only a few feet per second in small and weak cells and cells in earlier stages of development, to almost 100 feet per second in large well-developed cells.

In accordance with well-known precipitation theories, raindrop coalescence occurs when the cloud top has extended some distance above the freezing level. When the accumulation of water exceeds in amount and in drop size that which can be supported by the updraft, the drops begin to fall through the weaker portions of the updraft and the cell passes into the mature stage of development.

MATURE STAGE

In the mature stage the cell contains in the lower levels a pronounced downdraft adjacent to the updraft. The downdraft reaches downward from approximately 25,000 feet, and throughout the cell above that height the updraft continues. The rain at the surface is associated mainly with the downdraft portion of the cell. The structure is shown in Fig. 1.

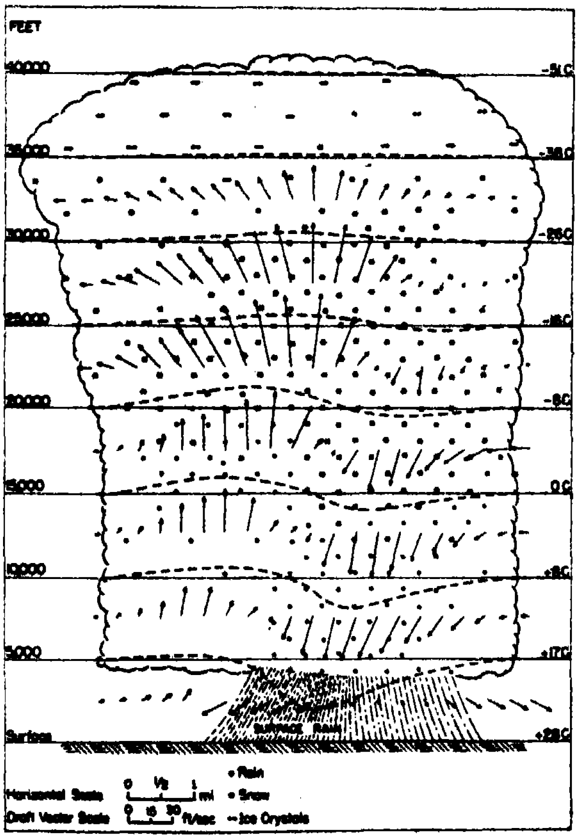

FIG. 1. Sketch of a vertical cross section through a thunderstorm cell in the mature stage, showing vectorially the air circulation. The temperature distribution shown is typical of summer thunderstorms in the eastern United States.

The downdraft results primarily from the presence of falling rain in an area of former updraft. The raindrops become so large and numerous that they exert a frictional drag on the air sufficient to change an updraft into a downdraft.

At this point in the description of the thunderstorm cell it is necessary to insert a few remarks concerning the thermodynamic processes. Classical treatments consider the ascending air from the point of view of the so-called "parcel method." In this process the rising air is regarded as changing its temperature with the expansion and water vapor condensation due to pressure decrease in such a way that it neither affects nor is affected by the environment air. In doing so, its temperature decrease follows the so-called wet-adiabatic rate. Laboratory experience and our atmospheric measurements show that the ascending air of the cumulus cloud behaves in much the same way as a vertical jet stream in the laboratory, in that it frictionally entrains part of the surrounding air. This means that air of less than saturation humidity comes into the cloud and mixes with the cloud air. In the active cumulus, there is enough liquid water being carried in the updraft to preserve saturation, in the face of intrusion of relatively dry air, without completely evaporating. That which evaporates in the mixing process loses part of the heat acquired in the cloud condensation process. As a consequence, the ascending air cools at a rate faster than the wet-adiabatic and at any point is very near the temperature of the environment.

When the frictional drag of the great mass of large raindrops finally changes the updraft to a downdraft, the descent involves increasing temperature at the wet-adiabatic rate, so the rate of warming in descent is less rapid than the cooling in the ascent. Mixing of outside air would tend to make the downdraft even colder, because of evaporation of raindrops. Thus the downdraft becomes a falling current of cold air which spreads out laterally as it strikes the ground.

All of the striking phenomena observed at the ground in thunderstorms are directly associated with the downdraft. Among them are the downpour of rain, the temperature discontinuity, the squall front or "first gust," the barograph "jump," the humidity "dip," and, to a considerable extent, the cloud-to-ground lightning discharge.

Either from the first gust of the wind that reaches out from the downdraft area or from air mass identification in terms of temperature, the outflow of the downdraft air can be traced with precision through the Florida and Ohio micronetworks. The data show that the cold air spreads outward almost equally in all directions in cases of gentle winds, but is carried downwind in a strongly diverging flow when the prevailing unperturbed winds are appreciable. A discontinuity is formed between the outflow air and the surrounding warm air. Although originally formed in the rainy portion of the cell, the downdraft air soon outruns the rain area and its arrival is felt at places several miles from the precipitating cell. The first blast of downdraft air experienced at a station is the strongest, but as long as the outflow continues, strong, gusty winds are observed. The strength of the first and succeeding gusts is less the farther the air has spread, being strongest near where the downdraft first reaches the ground in the early mature stage. There, and elsewhere, the wind speed and gustiness decrease with time as the spreading continues, except in those cases where a new adjacent cell reaches the mature or rain-producing stage.

Computations of the outflow made from a study of the wind field as measured in the surface micronetwork show very pronounced patterns of horizontal divergence centers with the maximum values in the heaviest rain at the point where the downdraft appears to be concentrated. The simultaneous release of balloons at several points around individual storms having mature cells indicated outflow from the ground up to heights between 2000 and 5000 feet, with inflow above. This measured inflow provides a verification of the idea of entrainment of environment air into the vertically moving air of the cloud. In the later mature stage and in the dissipating stage, outflow was measured by the balloons at heights above 25,000 feet, corresponding to the anvil portion of the cloud.

In general, one may say that, heretofore, meteorologists have emphasized too much the thunderstorm updraft. The downdraft is by far the most striking feature, at least in the levels at or near the ground. The inflow winds that feed the updraft are mere zephyrs at the ground, while the outflow from the downdraft produces winds occasionally of destructive force. Other striking changes, such as the temperature drop and the pressure jump, go with the downdraft. Also it is evident that as a thermodynamic engine the thunderstorm does work both through the updraft, which is warmer than the environment, and through the downdraft, which is colder. Temperatures measured from the airplanes amply demonstrated these temperature differences and, in fact, showed that the stronger the draft the greater the temperature difference, in the sense indicated.

DISSIPATING STAGE

When the downdraft has spread across the lower levels of the cell to such an extent that the updraft area becomes of secondary importance, the cell passes into the dissipating stage. As the process continues, the entire lower part of the cell has downdrafts, while in the higher levels there are negligible vertical motions. Slight downdrafts exist as long as light rain continues, although the entraining of environment air at this stage must be a contributing factor in drying up the cloud.

By the time the rain has stopped, large scale vertical motion has subsided and cell boundaries become very indistinct. The storm usually ends up as a dissipating layer of altostratus.

THE OUTFLOW AND NEW CELLS

One of the effects of the outflowing cold air which was immediately recognized and which was also known to previous investigators, was the action of the pseudo cold front in "triggering" the growth of new cells. It was found that the greatest probability for new cell development is in the region between two cells not more than three miles apart, where two cold outflows meet to squeeze the warm air upward. Downwind three miles or less from an existing cell is another place of importance for cell development.

In some cases the new cells developed before there had been time for the cold air outflow to make its influence felt. It seemed that frequently there was a tendency for cells to grow in clusters almost simultaneously. Some more general features of the dynamics of the air in the vicinity must be a contributing cause in these cases.

FLIGHTS THROUGH THUNDERSTORMS

During the two seasons of measurements, the Air Force pilots made a total of 1,363 penetrations through thunderstorms at various altitudes without accident. An effort was made to perform these flights through the most vigorous thunderstorms that could be found in the area of operations. The analysis of these flights furnishes valuable information concerning hazards in thunderstorms.

Turbulence was found to be greatest at the middle and upper altitudes flown, that is, from 10,000 feet upward, with the greatest values appearing between 15,000 and 20,000 feet. The least turbulence was found in the lower layers. Updrafts were strongest in the higher levels, as were also, to some extent, the downdrafts. The lightning and hail hazards were found to be greatest around 15,000 feet. In general, the worst conditions were encountered at the altitudes at which modern airplanes with supercharged cabins are most frequently flown. The use of airborne radar to avoid thunderstorm centers of turbulence, particularly at these upper levels, was indicated to be desirable. With 10-cm radar, it was found that the turbulence outside the cloud echoes was negligible compared with that inside. The possibility of developing radar to the extent that the smooth areas between the cells can be followed should lead to a satisfactory solution of the thunderstorm flying problem at all levels.

A Method for Estimating Volume-Surface Ratios

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WITH THE CONTINUED DEVELOPMENT of cytochemical and histochemical techniques and their increasing use in research involving problems in pathology and microscopic anatomy, there is increasing need for more accurate and speedier methods of analyzing the quantitative morphological characteristics of cells and tissues. In 1943 Chalkley (*2*) proposed a new method for estimating volume percentages of morphologic components in fixed preparations, or under proper conditions, *in vivo*. This method depends on the fact that if points are thrown at random on a block of tissue the percentage of points lying in any morphologic component will, as the number of points is increased, approach the percentage of the tissue block accounted for by the individual component. Tests in several different laboratories (*1, 5, 6*) have confirmed the original expectation that the method would prove expeditious and accurate.

In the present paper an attempt is made to extend this method to obtain estimates of the volume-surface ratio of morphologic components such as cells or nuclei. There are good reasons *a priori* for believing that changes in this ratio may be correlated with different physiological states, but until a method of measurement is available no confirmation of this expectation is possible. The method to be proposed takes as its point of departure Crofton's remarkable results (*3*) showing that if an indefinitely long line be repeatedly placed at random over a plane containing a closed figure, the average length of the chord intersected by the figure will be π area/perimeter, no matter what the shape of the figure, so long as it is not reentrant.

This result requires modifications in several respects before it can be used for the purpose at hand: a) it must be made applicable to lines of finite length; b) it must substitute some simple procedure for the laborious and inaccurate method of measuring chord length; c) it must be extended to cover reentrant figures; d) it must be extended to provide an estimate not merely of the area-perimeter ratio in the focal plane under observation but of the volume-surface ratio in three dimensions of which the observed focal plane is a two-dimensional sample.[1]

The first three of these modifications are accomplished by a single simple device. If we use a line of finite length, say r, and count the number of times the two end points fall in the interior of a plane figure, denoted by h for hits, and the number of times the line intersects the perimeter of the figure, denoted by c for cuts, then in a very large number of throws $rh/c = \pi$ area/perimeter for all closed figures, including reentrant ones (Fig. 1). The fourth modification is provided by the mathematical result that, when a line of length r is placed at random in three-dimensional space containing a closed figure, in a very large number of throws $rh/c = 4$ volume/surface.

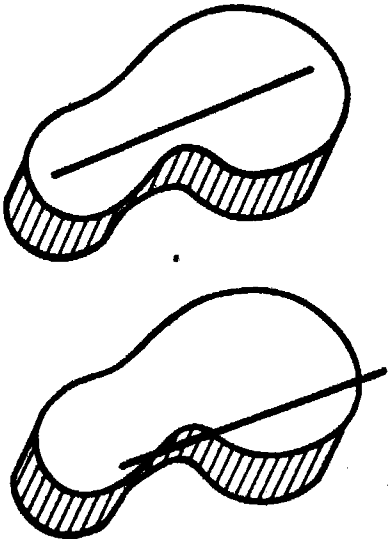

FIG. 1. Schematic representation of a randomly thrown line intersecting a closed three-dimensional figure. In the upper sketch the reading is two hits, no cuts; in the lower, 1 hit, 3 cuts.

This result satisfies condition *d*, since placing a line at random in three dimensions can be shown to be formally equivalent to placing a plane at random in three dimensions and placing the line at random on the resulting two-dimensional plane section.

If the space contains a series of figures of different volumes and surfaces, $rh/c = 4$ sum of volumes/sum of surfaces. As in two dimensions, this result applies whatever the shape of the figure, but covers reentrant as well as nonreentrant figures. Mathematical proofs are provided in a more complete discussion of this problem to be published elsewhere. It follows from this result that if a method can be found by which a

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[1] A related problem has been considered by Wicksell (*8, 9*). A large number of spherical or ellipsoidal corpuscles of different sizes are distributed in a body, split in two by a plane section. Wicksell expresses the distribution of the diameters of the corpuscles in the body in terms of the distribution of the measured diameters in the plane section.

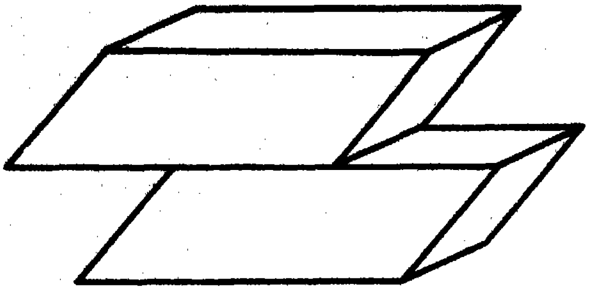

Fig. 2. Reentrant solid.

line of length r can be placed at random in a tissue and the hits and cuts on some specified morphological component counted, $\frac{1}{4}\, rh/c$ will yield an estimate of the average volume per unit of surface for that component.

Basic to the mathematical result is a particular definition of randomness. Other definitions, which lead to different results, are possible and cannot be excluded on purely mathematical grounds. Crofton's original result was criticized by Edgeworth (*4*) for this very reason. Although the definition used by Crofton and by us is the same as that used by Buffon in his solution of the needle problem (*7*), which solution has been empirically verified, a test of the method is nevertheless necessary.

For that purpose the following trial was conducted. Strips of balsa wood were sawed into geometrical figures of known shape. The figures we shall consider here are a cube $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$ in. and a reentrant figure found by taking two parallelepipeds $\frac{3}{4} \times \frac{1}{4} \times \frac{1}{4}$ in. and glueing one on top of the other to yield a figure of the shape shown in Fig. 2. The figures were dropped into a cardboard container filled with melted paraffin and talc and stirred. After cooling, the mixture was sliced into parallel sections, and all the resulting blocks were laid level, adjoining each other. Fig. 3 shows the resulting sections for the $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$-in. cubes. A needle was thrown onto the blocks 2000 times, and the number of hits and cuts made by the needle on the sections of the wooden blocks that appeared in the slices was recorded at each throw. After each 100 throws the sections were reshuffled. Fig. 4 shows the result for the cubes, Fig. 5 for the reentrant figure. In both cases the estimate of volume-surface ratio obtained differs from the known figure by less than 5%. This agreement appears satisfactory.

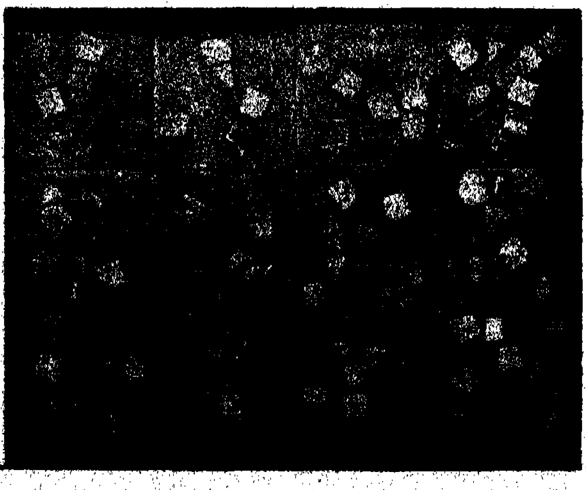

Fig. 3. Twelve parallel sections of ½-in. cubes embedded in paraffin. The reading for the particular position of the needle is 2 hits and 4 cuts.

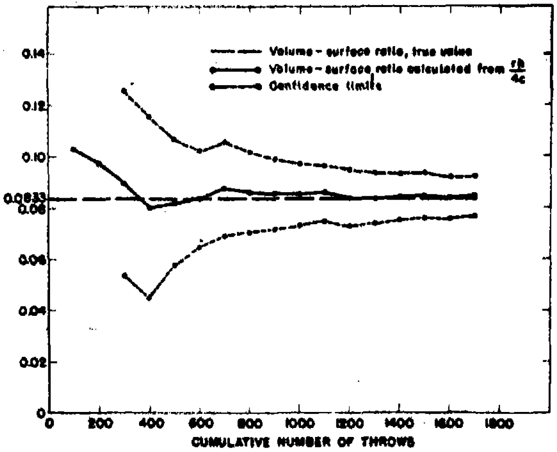

Fig. 4. Cumulative estimates from successive throws of volume-surface ratio for ½-in. cubes.

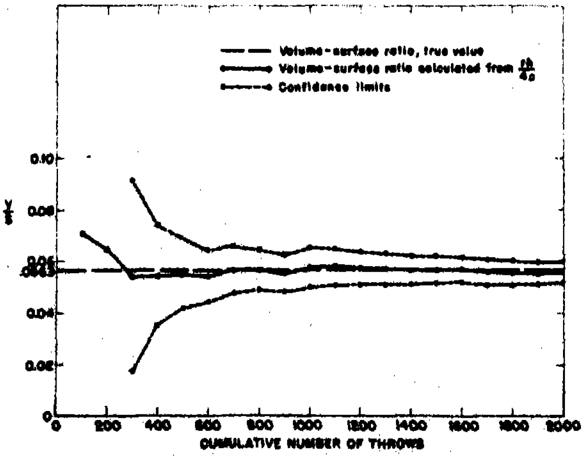

Fig. 5. Cumulative estimate from successive throws of volume-surface ratio for the reentrant figure.

The 95% confidence limits shown in Figs. 3 and 4 have been calculated from standard deviations computed from groups of 100 throws. They provide the basis for deciding when a sufficient number of throws has been made. Thus, after 2000 throws we can conclude, even in the absence of knowledge of the correct answer, that the correct value lies within 8% of the observed value with a probability of 0.95. After 1400 throws the correct value lies within 10% of the observed value, and after 900 throws within 15%. Thus, by calculating error limits it is possible to decide at any point when sufficient accuracy for the purpose at hand has been attained.

To determine the amount of subjectivity involved in reading hits and cuts, two different observers independently recorded hits and cuts for the same 2000 throws on the reentrant figure. In all doubtful cases they recorded separately their first and second choices. In no case do the differences exceed 6% (Table 1).

TABLE 1

ESTIMATES OF A TRUE RATIO OF 0.0563 INDEPENDENTLY OBTAINED BY TWO OBSERVERS FROM THE SAME 2000 THROWS

Observer	Estimated $\frac{V}{S}$ based on	
	Use of first choice	Use of second choice in doubtful cases
A	0.0584	0.0572
B	0.0557	0.0550

In applying the present method to microscopic sections, the major problem is in achieving randomness. When the morphologic components under study are not oriented, or when they are approximately spherical, the technique used by Chalkley for achieving randomness (*2*) should be satisfactory. For this purpose a reticle with a line of suitable length engraved or otherwise inscribed thereon is substituted for the five pointers used in the method referred to. The manipulation is identical but cuts as well as hits are observed and recorded. Of course, the length of the visual image of the line in the focal plane must be measured for the particular magnification used, and treated as the contant *r* in the calculations. When the components are oriented and are not approximately spherical, however, parallel sections cut through the tissue will not provide random sections. In such cases special precautions will be needed to insure randomness.

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TECHNICAL PAPERS

The Enzymatic Hydrolysis of Chloramphenicol (Chloromycetin)[1]

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With the development of the new antibiotic chloramphenicol, (chloromycetin) (*1, 3, 6*) and identification as D(-) threo-1-*p*-nitrophenyl-2-dichloracetamido-1, 3-propanediol (*2, 4, 5*), experiments were undertaken to determine if this compound could be inactivated by enzymatic hydrolysis of the amide linkage present in the compound. This linkage appears to contribute substantially to the bacteriostatic properties of chloramphenicol.

In the initial series of experiments with *E. coli*, *B. mycoides*, *P. vulgaris*, and *B. subtilis*, it was found that chloramphenicol could be hydrolysed when introduced into actively growing broth cultures of these organisms. The decrease in bacteriostatic potency of the filtrates from these cultures was followed by means of a microbiological assay method for chloramphenicol using *Shigella sonnei* (*6*).

The organisms tested showed considerable variation in ability to hydrolyze the antibiotic. *P. vulgaris* and *B. subtilis* proved to be the best source of the enzyme. Cultures of these organisms possessed approximately twice the enzymatic activity of *B. mycoides* cultures and about three times the activity exhibited by *E. coli* cultures.

The results obtained, using actively growing cultures, did not indicate whether the enzyme destroying the antibiotic was an extracellular or endocellular enzyme. When filtrates from 24-hr broth cultures of the organisms were incubated for 24 hr at 37° C with chloramphenicol, no hydrolysis of the antibiotic was observed. However, filtrates from cultures 2–4 weeks of age actively destroyed chloramphenicol and a fairly active preparation of the enzyme could be obtained by concentration of the filtrate. The enzyme is therefore liberated into the culture medium. The enzyme could also be detected in suspensions of washed bacterial cells and in the autolyzates prepared from the washed cells.

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[1] Trademark Parke, Davis & Company.

The enzyme involved in the hydrolysis of chloramphenicol has been tentatively designated as enzyme A to distinguish it from the other enzymes which might be involved in the enzymatic destruction of the antibiotic through attacks on other groups present in the molecule. The action of the enzyme is to hydrolyze the amide linkage of chloramphenicol and thus liberate the corresponding basic amine and dichloroacetic acid, which have been isolated and identified by chemical means from the enzymatic digests of chloramphenicol.

The optimum conditions for the enzymatic hydrolysis of chloramphenicol have been found to be pH 7.5 and a temperature of 37.5 to 40.0° C. The rate of enzymatic hydrolysis increased with substrate concentration up to 2 mg per ml. This is approximately the maximum solubility of chloramphenicol under the test conditions.

One unit of enzyme activity has been arbitrarily chosen as that amount of the enzyme which will hydrolyze 1 μg of chloramphenicol in 1 hr at pH 7.5 and 37.5° C.

Initial studies on the properties of this enzyme involved in the hydrolysis of chloramphenicol indicate that it is probably very similar to other proteolytic enzymes that have been isolated from bacterial cells. Moreover, this enzyme is neither a true papain nor a trypsin, since highly active preparations of these latter enzymes do not hydrolyze chloramphenicol to any great extent. The enzyme appears, however, to be activated by cysteine and other reducing agents, so that it is probably more closely related to the papain group than to the trypsin group of enzymes. Crystalline preparations of pepsin and chymotrypsin were found to be inactive on chloramphenicol.

Further studies on the distribution and properties of this enzyme are in progress and will be reported later.

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Absorption Spectrum of Beta Carotene in Liquid Solution at the Temperature of Liquid Nitrogen[1]

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In a recent paper in another journal (*1*), we describe solutions of salts fluid at the temperature of liquid nitrogen. One of the solvents employed consists of one part in ten of *n*-propyl alcohol and the remainder is equally divided between the liquids propane and propene.

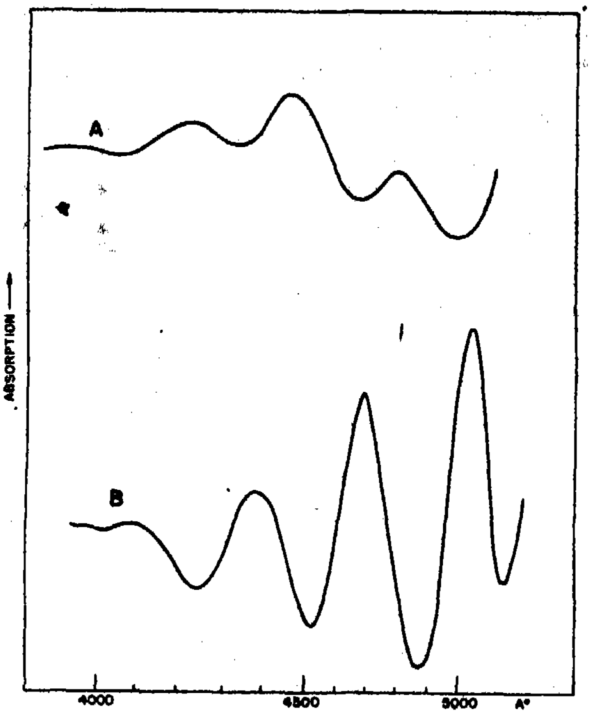

FIG. 1. Absorption spectra of carotene (90% alpha and 10% beta). A—In heptane at room temperature; B—In equal volume mixture of propane and propene at − 196° C.

To obtain as refined a spectrum of a solute as possible, it is recognized that solvents such as alcohol and ether are to be avoided, since they possess permanent electric dipole moments, and they would be expected to distort the solute molecules. For this reason, hydrocarbons such as hexane frequently serve as solvents.

Our mixed solvent without alcohol, namely, a solvent consisting only of liquid propene and liquid propane in equal volumes, proved to dissolve carotene rather rapidly at about − 50° C and maintain it in solution at − 196° C in sufficient concentration to give an absorption spectrum in a path length of 25 cm.

The spectrum at − 196° C, as may be seen from the traces, differs markedly from that of carotene at room temperature dissolved in heptane. The number of absorption peaks seems to be the same, but their relative intensities differ greatly. They are much sharpened and are in general displaced toward long wavelengths at the low temperature.

On lowering the temperature of the solution in propane-propene from − 80° C to − 196° C, changes consistent with these took place.

The solute consisted of 90% beta carotene and 10% alpha carotene.

We are much indebted to Dr. Martin Kuna, of our Biology Division, not only for some biologically important substances but also for a discussion of great value to us on their chemical and spectroscopic properties.

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[1] This document is based on work performed under Contract Number W-7405 eng 26 for the Atomic Energy Project at Oak Ridge National Laboratory.

An Interpretation of the Cause of Water-repellent Sandy Soils Found in Citrus Groves of Central Florida

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Several reports (*3–5*) have appeared in soil literature discussing the property which prevents the soil from being properly wetted by either rain or irrigation water. This property, water repellency, is widespread and quite pronounced in much of the citrus-growing area of Florida. Under many trees a large volume of soil remains dry even after prolonged periods of rainfall. A drop of distilled water, placed on the soil, behaves as if it were on a waxed surface. In some cases the drop of water will evaporate in place without any penetration; in other cases it will gradually penetrate the soil after several hours.

During the rainy seasons of 1947 and 1948, differences in the prevalence of water-repellent soil were noted in a group of plots having different fertilizer treatments, located at the Citrus Experiment Station at Lake Alfred, Florida. The treatments had been in effect 10 years. Determinations of the relative amounts of water-repellent soil were estimated by placing a drop of distilled water on soil samples taken from beneath trees and observing the time required for absorption. This was done by taking samples to a 6-in. depth with a stainless steel tube 1 in. in diam, turning the sample tube upside down and placing the drop of water on the exposed soil surface. If the drop of water did not soak into the soil within 10 sec, the soil was listed as water repellent; if it did soak in, it was listed easy to wet. Eighty examinations were made in each plot and the results from duplicate plots combined. The results of this investigation are shown in Table 1.

These results indicate that fertilizer practices influence the amount of water-repellent soil found under field conditions. It appears that the use of magnesium in the fertilizer, along with a separate application of ground limestone to control soil pH at about 5.8, is associated with the water-repellent phenomenon.

It is known that fatty acids form very insoluble soaps with calcium, magnesium, and other metals and that these soaps, when dry, are extremely water repellent. Waksman (*6*) had previously cited the presence of fatty acids, fats, and waxes in soils. With this in mind, several composite soil samples which exhibited the water-repellent property were checked for the presence of fatty acids. This was done by heating the soil in the presence of a strong sodium hydroxide solution, neutralizing with sulphuric acid, and steam-distilling in the presence of a slight excess of acid. A small amount of solid material was obtained which gave a test for a carboxylic acid group (*1*).

A dilute ether solution of the solid material obtained from this steam distillation, when added to subsoil, which wet very easily, had no effect on its wettability. However, when a dilute aqueous solution of calcium or magnesium hydroxide was added to the soil, which had been previously treated with the ether extract, the soil became very water repellent when it was dry.

This was further checked by treating an easily wetted soil with a dilute solution of stearic acid in ether. The ether was evaporated and then a dilute solution of either calcium or magnesium hydroxide was added and the soil dried. Following this treatment the soil became extremely water repellent. Evidently the formation under field conditions of metallic soaps results in water-repellent soil and a similar water repellency can be produced in the laboratory by similar chemical combinations.

TABLE 1

Relationship of Fertilizer Treatment to Amount of Water-repellent Soil

Plot Nos.	Fertilizer treatment	July 1947 % water-repellent soil	August 1948 % water-repellent soil
1 and 12	3-6-8-4-1-½* 40% N organic source pH 5.8†	23	18
2 and 11	3-6-8-0-1-½ 100% N inorganic source pH 5.8†	4	1
3 and 10	3-6-8-2-1-½ 100% N inorganic source pH 5.8†	29	30
4 and 9	3-6-8-4-1-½ 100% N inorganic source pH 5.8†	23	23
5 and 8	3-6-8-4-1-½ 100% N inorganic source pH not controlled (4.2)	0	1
6 and 7	3-6-8-0-0-0 100% N inorganic source pH not controlled (4.2)	5	8

* The figures refer to percentages of various constituents in the fertilizer in the following order: N-P_2O_5-K_2O-MgO-MnO-CuO and as determined by A.O.A.C. methods for fertilizers. The fertilizers indicated were applied at 60 lb per tree per year.

† pH controlled with high Ca limestone.

Jacobson and Holmes (*2*) found that metallic soaps, such as magnesium stearate, are practically insoluble in ether, but that magnesium stearate is relatively soluble in methyl alcohol. Jamison's work (*4*) indicated that a water-repellent soil, extracted with ether, remains water repellent. With these facts in mind a sample of water-repellent soil was extracted first with ether to remove any free fats and waxes, then with methyl alcohol. This treatment left the soil readily wettable. The methyl alcohol extract, when evaporated on an easily wetted soil, left the soil water repellent, whereas the ether extract had no effect. When a portion of the methyl alcohol extract was evaporated to dryness, nitric and perchloric acids added for destruction of organic matter, and heat applied, small globules of fat were released. Further heat oxidized the fat, and the residue, when taken up in distilled water, gave strong magnesium and calcium tests.

This indicates that calcium and magnesium soaps had been dissolved by the methyl alcohol.

From this and other corollary information, it has been concluded that it is the formation of a water-repellent coating of metallic soaps on the soil particles (98% silica) that causes the water-repellent property found in many Florida soils. The source and identity of the particular fatty acids involved have not yet been determined.

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Near Infrared Absorption Spectra of Uracil, 5-Chlorouracil, and Thymine[1]

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Infrared spectrometry has proved very useful in studying biologically active materials (*5*), particularly if they are soluble in solvents which are transparent in the same region of the spectrum. In proteins (*1, 4*) and the components of nucleic acids (*2, 3*), the lack of solubility in other than aqueous solvents has made it necessary to use thin films, powders, suspensions, and the like. We have found that fused antimony trichloride is a powerful solvent for some of these materials and nearly 0.2 molar solutions of uracil, 5-chlorouracil, and thymine were readily prepared at 100° C. After a vacuum distillation, the fused antimony trichloride was suitably transparent and showed only two small absorption peaks at 1.93 and 1.42 μ (believed to be an O-H stretching overtone). These peaks cause no trouble, since their effect is subtracted out with the background. We have not investigated the absorption spectra of antimony chloride beyond 2.3 μ, but one might reasonably expect it to be transparent as far out as carbon tetrachloride or perhaps silver chloride. This aspect of the problem is being studied further.

The near infrared spectra of the compounds reported in this paper were measured with a Perkin-Elmer spectrometer model 12-B. A flint glass prism and tungsten light source were used, with a constant slit width of 0.475 mm. The absorption cell was constructed of Monel metal and had a diameter of 2.5 and a length of 4.0 cm. Glass windows were used with Teflon gaskets. The cell was heated electrically to 100° C.

The results obtained are shown in Fig. 1 and tabulated in Table 1. For comparison we have included the absorption spectra of phenol and acetamide. The concentrations are about 0.2 molar. In addition, chlorouracil absorption curves were run at 0.18, 0.28, and 0.43 molar. The effect of increasing the concentration of chlorouracil is simply to deepen the various absorption bands. No broadening characteristic of hydrogen bonding was obtained, and we infer that in this solvent compounds are present in a monomeric form.

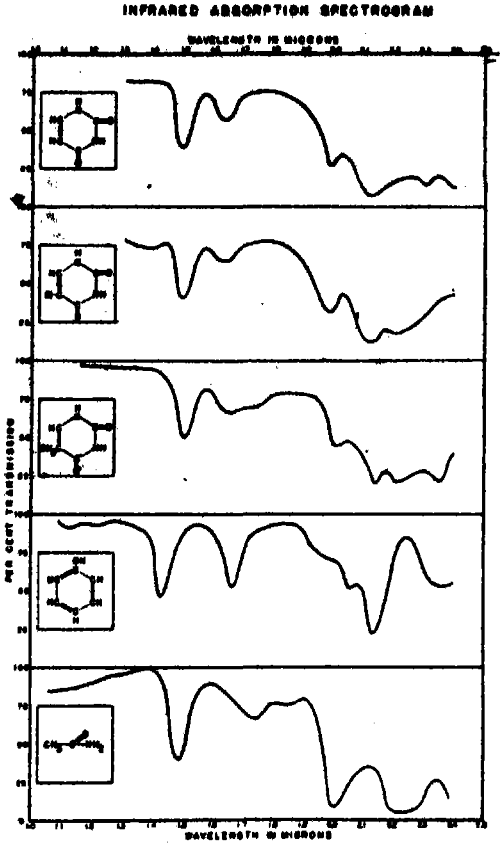

Fig. 1.

TABLE 1

Near Infrared Absorption Bands (in Antimony Trichloride)

Uracil	5-Chloro-uracil	Thymine	Phenol	Acet-amide	Assignment
ab	ab	ab	1.43	ab	O-H
1.50	1.50	1.51	ab	1.49	N-H
1.65	1.65	1.68	1.67	ab	C-H (ring)
ab	ab	1.75	ab	1.75	C-H (aliphatic)
1.99	1.99	2.00	ab	2.00	C-O ?
2.13	2.13	2.14	2.14	ab	C-H (combination, ring)

Uracil, chlorouracil, and thymine all show sharp, deep bands at 1.50 μ. Bath and Ellis (*1*) concluded from a study of various proteins that absorption at this wavelength corresponds to the first N-H overtone. The very deep band at 1.49 μ in the spectrum of acetamide confirms

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[1] Supported in part by the Atomic Energy Commission and the Office of Naval Research.

this assignment. In phenol strong absorption occurs at 1.43 μ. This corresponds to the first O-H overtone. Since uracil and its derivatives do not absorb in this region but do absorb in the region characteristic of the first N-H overtone, it is inferred that these compounds exist predominantly in the keto form when dissolved in antimony trichloride.

The absorption at 1.65 μ shown by uracil, chlorouracil, and thymine is attributed to the first C-H overtone characteristic of ring compounds. The absorption is quite strong for phenol, which has five such hydrogen atoms, and quite weak for chlorouracil, which has only one C-H bond per molecule. The broadening of the C-H band toward the infrared in the case of thymine can be attributed to the aliphatic C-H overtone of the methyl group. The second dip in this broad band is centered at 1.75 μ, which coincides nicely with the methyl type C-H band of acetamide.

Uracil, chlorouracil, thymine, and acetamide show absorption at 1.99–2.00 μ; this band is absent in phenol. It is probably due to the second carbonyl overtone vibration which is known to lie in this region (*1*). All of the compounds except acetamide absorb at 2.13 μ. This band may be due to a combination of the fundamental valence and deformation vibrations of a ring C-H group. Beyond 2.1 μ the results are uncertain because the flint glass prism begins to absorb strongly and reduces the light intensity. Complete details of the spectra will be published elsewhere.

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Experimental Mixed Infection of Mice with Lansing Poliomyelitis Virus and Western Equine Encephalomyelitis Virus

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The phenomenon of interference between virus agents has been claiming increasing attention during the last decade. Interference has been demonstrated between plant viruses, between bacterial viruses (bacteriophages), and between animal viruses. In some cases when interference occurs the growth of one virus is inhibited, as evidenced by failure subsequently to demonstrate its presence (*1*, *6*), while in other cases the growth of both viruses is inhibited (*3*). On the other hand, it has been shown that two viruses may grow together without apparent interference (*4*, *5*).

In an attempt by the author to demonstrate interference between the viruses of equine encephalomyelitis and poliomyelitis in mice, it became apparent that such interference reported in monkeys (*2*) did not occur in mice. It was evident that both viruses grew in mice and that either or both could produce symptoms and death. If any antagonistic effect at all was manifested it consisted solely of a prolongation of life in some of the mice.

Lansing poliomyelitis and western equine encephalomyelitis viruses were chosen because their incubation periods and symptomatology made it easy to distinguish between them in mice. Because the Lansing virus has an incubation period averaging 7–9 days and the W.E.E. virus kills regularly in 48 hr, the W.E.E. virus was inoculated later so that both viruses could reach effective concentrations at about the same time. Accordingly, several preliminary experiments were run to work out the mutual relationships of dosage and time interval between administration of the viruses.

In one of these experiments using 30 mice it became apparent that LD_{50} doses of the two viruses would not give significant data without the use of extremely large groups of animals. It seemed desirable that all animals in the two control groups (Lansing virus alone and W.E.E. virus alone) should die in a reasonable period of time. Titration of the W.E.E. virus showed that 0.03 ml of a 1:1000 dilution inoculated intracerebrally would kill all mice injected in 2–3 days. The Lansing virus, however, presented a more complex problem. A single intracerebral inoculation of the supernatant fluid (allowing suspension to stand for 10–15 min for settling of coarser tissue fragments) of a 10% suspension of mouse brain and cord never killed all of the mice injected, and even among those that did die the incubation period of some was prolonged to 2 or 3 weeks. However, killing of all mice could be achieved by two inoculations of virus spaced 48 hr apart. Further, this served to shorten the incubation period somewhat. The preliminary experiments showed also that a time interval of 3 days between the second inoculation of Lansing virus and the administration of W.E.E. virus would probably be optimal.

A group of 62 10-g white mice were used for the experiment here reported. Fifty-two of these mice received two intracerebral inoculations of Lansing virus spaced 48 hr apart. One mouse was killed by the inoculation procedure. On the morning of the third day following the second injection, 14 of these mice were either dead, moribund, or showed typical poliomyelitis paralysis. These were arbitrarily set aside to constitute a poliomyelitis virus control group. The remaining 37 Lansing mice, together with the ten uninoculated mice, were injected with W.E.E. virus. The ten W.E.E. mice all died with typical symptoms in 48 hr. Of the 37 mice receiving both viruses, 17 died in 2–17 days with typical poliomyelitis symptoms, 11 died in 2–3 days with typical W.E.E. symptoms, and eight died in 1–9 days with what were judged to be mixed symptoms. One mouse did not die.

The brains and spinal cords of five of the mice receiving both viruses and dying with typical poliomyelitis symptoms were removed. The cord and brain stem were removed from each brain and the cords and brains pooled separately. These were ground, diluted to 1:100 and 1:1000 and injected into white mice, all of which died in 48 hr with typical W.E.E. symptoms. Similar results were obtained with brain and cord material removed from mice dying with W.E.E. symptoms and from mice dying with symptoms judged to be a mixture of the two diseases.

It is apparent that mice dying with typical poliomyelitis symptoms had W.E.E. virus in high concentration in the central nervous system, and it seems reasonable to infer that there was a concomitant growth of these viruses. It seems reasonable further to assume that whether a mouse died with poliomyelitis or encephalitis was a fortuitous circumstance depending on which virus happened to gain the ascendancy. Unfortunately, the long incubation period of poliomyelitis virus and the short incubation period of W.E.E. virus precluded the possibility of demonstrating the presence of poliomyelitis virus in mice dying with W.E.E. symptoms.

The question why certain viruses interfere with each other while other viruses may grow together in the same host organ or tissue remains unanswered. The observations here reported, that equine encephalomyelitis virus and poliomyelitis virus may grow together in the brains of mice, whereas these viruses interfere with each other in monkeys, do not clarify the situation but nevertheless provide additional information. An elucidation of this fundamental problem will undoubtedly add greatly to our knowledge of the basic mechanisms of virus growth.

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Thyroid Destruction by I^{131}, and Replacement Therapy[1]

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The early work of Graham (*1*) on milk cows, and of Winchester (*5*) on chickens demonstrated a very definite relationship between thyroid function and milk and egg production. Winchester (*6*) also found a parallelism between thyrotropic hormone content of the pituitary, basal metabolism, and egg production of hens. Subsequently, numerous reports have been made concerning the use of various drugs that in one way or another influence metabolism, and eventually the production of farm animals (*3, 4*). The literature is characterized by a certain amount of disagreement as to the effects of the drugs, and emphasizes the need for further research on the fundamental aspects of thyroid function.

This report presents a method by which thyroids of young chickens have been eliminated by I^{131} irradiation, apparently without damage to the animal other than some possible destruction of parathyroid tissue; a procedure similar to that of Gorbman (*2*), who has reported 100% destruction of thyroids of 2–5-month-old mice by I^{131} injected in doses ranging from 18 to 55 mc of activity per kg of body weight. The work reported here, however, deals with thyroid destruction by I^{131}, or radio-thyroidecrexis,[4] during the first few days of life rather than after the animal has reached full size. Further, by means of thyroxin therapy, birds lacking thyroid glands were brought to full size and into egg production, while similar birds that did not receive thyroxin survived for limited periods only, and grew very slowly.

TABLE 1

Iodine 131 Dosage and Percentage Thyroid Destruction (Results of Five Trials)

Dose I^{131}	No. of chicks	Exposure period	Estimated thyroid destruction
mc/100 g		days	%
1–1.9	2	5	0
	1	over 24	10
2–2.9	1	5	10
	1	5	50
	1	over 24	75
3–3.9	1	over 24	90
	4	over 24	100
4–4.9	1	5	nearly 100
	1	over 24	90
	4	over 24	100
5–5.9	1	5	nearly 100
	4	over 24	100
6–6.9	2	over 24	100
9.2	2	over 24	100

The birds used in these experiments were New Hampshire chicks, obtained from a commercial hatchery, and weighed 40–66 g at the time of I^{131} injection.

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[1] Published with the permission of the Director of the Florida Agricultural Experiment Station.

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[3] Present address: University of Tennessee, Knoxville, Tennessee.

[4] Since the literature apparently includes no term indicative of thyroid elimination by other than surgical means, the authors have deemed it necessary to introduce a suitable term in order to avoid undue repetition and use of descriptive material. After due consideration, the term "radio-thyroidecrexis" (pronounced *e-krek'-sis*) has been selected to indicate total destruction of the thyroid gland in the live animal by means of a radioactive substance such as I^{131}. Grateful acknowledgement is due Dr. Joseph Brunet, professor of ancient languages, University of Florida, for his cooperation in offering a number of possible terms from which a final selection was made by the authors.

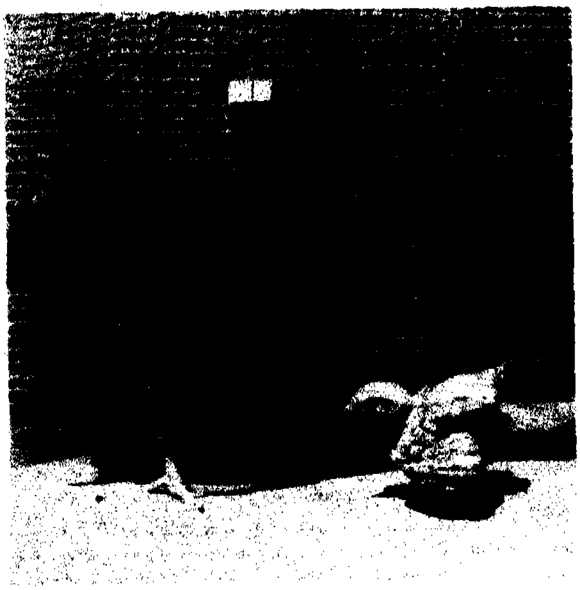

FIG. 1. Influence of radio-thyroid-ecrexis on growth. Control at left, I^{131}-injected bird at right. Both birds photographed at 7 weeks of age.

Carrier-free I^{131} in solution of pH 7–9, which had been prepared by pile-bombardment of tellurium, was used in this work. The values given for the activities of I^{131} were based upon the Oak Ridge National Laboratory measurements and refer to the activity actually injected.[5] Suitable precautions were used to make sure that persons were not exposed to above-tolerance radiation during administration of the isotope and handling of the birds. The I^{131} injections were given intraperitoneally and the puncture was sealed in most cases with collodion.

FIG. 2. Effect of thyroid replacement therapy on a bird lacking thyroid. Normal control at right, thyroid-ecrecticized bird injected daily with thyroxin at center. The three birds were 5 weeks of age when photographed.

The wing was used as the site of intradermal injection of synthetic D,L-thyroxin in water suspension. A commercial starting and growing mash was fed all birds, and to compensate for possible parathyroid injury, 0.5% calcium gluconate was added to the ration.

On autopsy, sections of thyroid tissue were prepared by the freezing technique in the first two trials, and serial sections were prepared in later experiments.[6] When no trace of the thyroid capsule was found in I^{131}-treated birds, a mass of tissue that included the normal thyroid site was prepared for sectioning.

The degree of thyroid destruction accomplished by various doses of I^{131} and lengths of exposure to radiation are given for five of six trials in Table 1. These results indicate that doses of about 6 mc or more of activity per 100 g of body weight over periods of 24 days (three times the half-life of I^{131}) accomplished complete destruction of the thyroids in the five trials. An anomalous situation existed in the case of trial No. 4, in which even 6.5 mc of activity failed to accomplish complete thyroid destruction. The results of this trial are not included in this report. No explanation has been found for the negative results obtained in this one trial.

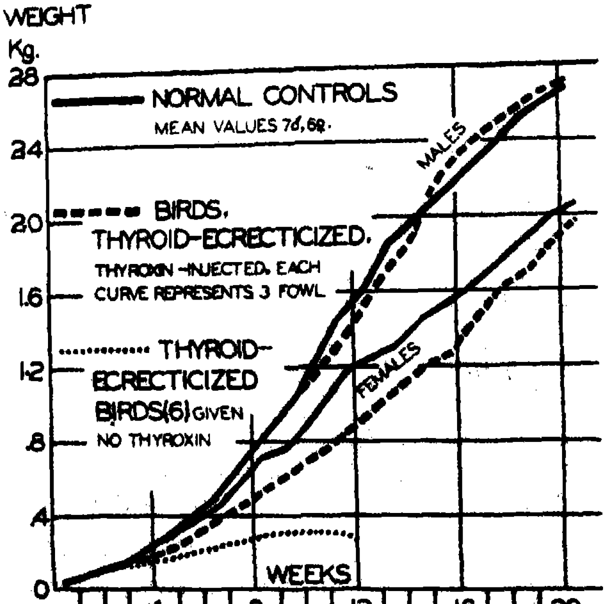

FIG. 3. Influence of radio-thyroid-ecrexis on growth, and of thyroxin on growth of birds lacking thyroids.

Injected chicks, in which thyroids were not found on autopsy, grew very slowly and survived only a limited time after injection (7–18 weeks) unless they were given thyroid replacement therapy. In Fig. 1 are shown a control bird and a thyroid-ecrecticized chick, both 7 weeks of age. In trials 5 and 6 the smaller of each pair of chicks injected with I^{131} at a given level was selected about 2 weeks after injection for replacement therapy. Thyroxin in water suspension was injected daily at a level of 3.8 μg in trial 5, and 5.7 μg in trial 6, per 100 g body weight.

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[5] The radioactive iodine was supplied by the Oak Ridge National Laboratory on allocation from the U. S. Atomic Energy Commission. The ratio of the Oak Ridge National Laboratory millicurie unit of I^{131}, used in the work reported here, to the new National Bureau of Standards millicurie unit is 1.75 : 1.00.

[6] Grateful acknowledgement is due Drs. Nelson A. Murray and Lucien Y. Dyrenforth, of Jacksonville, Florida, in whose laboratories most of the sections were prepared.

The first visible response to thyroxin injection was rapid resumption of growth. In Fig. 2 are shown a normal control bird, an I^{131}-injected bird, and a thyroid-ecrecticized chick given daily injections of 3.8 μg thyroxin daily.

TABLE 2

EGG PRODUCTION OF THYROXIN-INJECTED HENS AND OF CONTROLS

Hen No.	Dose I^{131} in mc per 100 g body wt	Laid first egg at age in weeks	Egg material per week in g
34	3.1	20	156
56	6.9	19	169
59	9.2	..*	...*
35	0	20	144
54	0	22	Entered production 4 days prior to autopsy

* Condition of the reproductive organs indicated that Hen No. 59 would have laid at an early age.

In Fig. 3 the growth rates of thyroid-ecrecticized, thyroxin-injected birds are compared with those of normal controls, and thyroid-ecrecticized chicks that did not receive thyroxin. Growth and feather development were quickly resumed after the initiation of thyroxin therapy, and some thyroxin-treated birds actually became larger than the comparable normal controls.

Since ionizing radiations are known to have profound effects on the reproductive organs, the egg-producing ability of thyroid-ecrecticized birds, treated with thyroxin, is of particular interest. The experiment was terminated before more than two of the control females had entered production. Two of the three thyroid-ecrecticized females ovulated, and as is shown by Table 2, their rates of production were excellent when the age of the birds is taken into consideration. A third experimental female that received the relatively large dose of 9.2 mc of activity per 100 g body weight was found on autopsy to have developed normally, and presumably she would have laid at an early age.

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Microcrystallographic Data on Sodium-D-Glutamate (Monosodium Glutamate)

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During the period 1936–1940 the writer had occasion to examine microscopically samples of a substance which at that time was considered somewhat of a novelty as a table condiment. This material was the Japanese "Aji-No-Moto," long known and crudely prepared in the Orient as a food supplement. The samples submitted, however, were not pure, containing an appreciable amount of salt and other impurities. The method used for the examination of the material was that which had been previously applied to a microscopic study of the common crystalline amino acids (*4*).

More recently the writer had an opportunity to examine a pure sample[1] of sodium-D-glutamate for the purpose of placing on record the significant optical crystallographic properties of the substance. The increasing widespread interest in monosodium glutamate as a seasoner of foods (*1, 2, 5, 6*) appears to justify a more complete microscopic description than has hitherto appeared. Partial crystallographic and optical data have been recorded (*3, 7*), including only one refractive index.

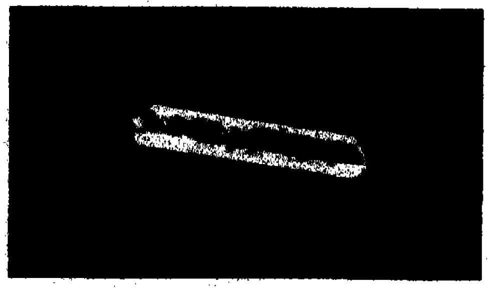

FIG. 1. Sodium-D-glutamate (typical habit).

Microscopic examination of monosodium glutamate ($C_5H_8O_4NNa$) shows that it is crystalline, apparently crystallizing in the monoclinic system, elongated, prismatic forms characterizing the habit (Fig. 1). In parallel polarized light (crossed Nicols), the crystals are elongated parallel to axis *b*, showing parallel extinction and negative elongation. In convergent polarized light (crossed Nicols), partial biaxial interference figures occur, the optic axis figure being most usually shown. Optic sign (−). Refractive indices: $\alpha = 1.500$, $\beta = 1.550$, $\gamma = 1.592$, all ± 0.002.

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Aureomycin and Blood Coagulation

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Moldavsky, Hasselbrook, and Cateno (*5*) were the first to report that the blood of patients receiving injections of penicillin clotted much more quickly than normally. These observations were corroborated and extended experimentally in animals and human beings by Macht (*1*) both after parenteral injections and when administered by stomach. Macht further determined the relative thromboplastic efficiency of the four principal penicillins G, X, F, and K; and also found that streptomycin shortened the coagulation time of whole blood. The clinical bearings of these findings in regard to possible thromboembolic accidents have been also discussed by him (*2*). Recently, the antibiotic aureomycin, discovered by B. M. Duggar, has been introduced into medical practice. It was therefore deemed worth while to study its influence, if any, on blood coagulation.

TABLE 1

EFFECT OF AUREOMYCIN ON BLOOD COAGULATION TIME IN RABBITS

Rabbit	Wt in kg	Normal coag. time in min	Aureomycin in mg	Coag. time in min*	Coag. time in min†
A	3	11	15	9	7
B	2.8	11	10	9	7
C	3.4	10	100	5	1.5
D	2.5	11	65	3	3

* Tested about 1 hr after administration of drug.
† Tested in about 1½–3 hr after administration of drug.

Experiments with aureomycin were made on rabbits and cats, and clinical tests were made on patients who had not received any previous medication. In all of the experiments, the drug was administered by stomach. The clotting time of whole blood was measured by the Lee and White method before administration of aureomycin, and at various intervals afterward.

Table 1 shows the results of 4 rabbit experiments, in which various doses of aureomycin were given to the animals. It will be seen that in each case coagulation time was markedly shortened. Blood in all these was secured by cardiac puncture.

Table 2 gives results of an experiment on a cat and illustrates strikingly that no change occurred in coagulation time of blood taken repeatedly from the carotid artery before giving aureomycin. It shows also the progressive diminution in clotting time after administration of this drug.

TABLE 2

EFFECT OF AUREOMYCIN ON BLOOD COAGULATION TIME OF A CAT*

When tested		Coagulation time in min
10.10 A.M.		10.5
10.20 "		11.5
10.30 "		11.5
10.35 "	200 mg Aureomycin	
11.20 "		8
11.30 "		6
11.40 "		4
11.50 "		4

* Wt—4 kg.

Table 3 presents the findings obtained in 14 patients before and after administration of aureomycin. The patients were given one or two capsules of aureomycin of 250 mg each, the usual clinical dosage. It will be seen that in every case some shortening in coagulation time was produced. Control experiments on human subjects who did not receive aureomycin did not reveal such changes after repeated blood examinations.

TABLE 3

EFFECT OF AUREOMYCIN ON BLOOD COAGULATION TIME OF HUMANS

Patient	Dose in capsules*		Coagulation time in min before dose	Interval hr and min	Coagulation time in min after dose
Mr. D.W.	1	8	1	30	5
Mrs. S.	1	10.5	1		7.5
Mrs. G.	1	9	2		7
Mrs. K.	2 (1 hr apart)	10.5	1	20	3.5
Mr. Z.	"	10	1	20	7
Mrs. P.	2 (together)	14.5	1	45	8.5
Mrs. I.R.	"	12	1	30	9
Mr. C.	1	8.5	1		7
Mrs. B.	1	11	2	30	7.5
Mrs. M.	1	11	2	30	7
Mrs. D.	1	12	2	30	8
Mrs. B.R.	2 (1 hr apart)	9	3	30	6
Mrs. Z.K.	"	9	3	30	6
Mr. J.	"	9	3	30	6.5

* Each capsule contains 250 mg aureomycin.

Tests made on both human subjects and lower animals revealed no difference in prothrombin time, thus indicating that the diminution in clotting time is due to other factors involved in blood coagulation. Repeated tests of blood sera before and after administration of aureomycin revealed phytotoxic properties when tested by the author's phytopharmacological technique (*4*), as found in penicillin and streptomycin (*1*). Experiments now in progress with chloromycetin indicate similar properties.

The findings with aureomycin are of considerable practical clinical interest. There is undoubtedly a definite shortening of clotting time noted at the height of antibiotic therapy. While ordinarily nature provides a wide compensatory mechanism for prevention of thrombo-embolic accidents, still the coagulatory apparatus may be considered as in a metastable state, so that sudden physiological disturbances might precipitate thrombo-embolic accidents. Hence suitable prophylactic measures by use of anticoagulant drugs may be instituted.

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Body Retention of Carbon 14 from Labeled Sodium Bicarbonate[1]

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In view of the present wide usage of carbon 14 and the concern regarding possible radiation hazard involved, it is believed that certain data obtained on this subject are worth recording at this time. Bloom, Curtis, and McLean (*2*) and Armstrong, Schubert, and Lindenbaum (*1*) have previously published results indicating long term body retention of C^{14} from water soluble and insoluble carbonates. Brues and Buchanan (*4*) have reported some interesting results on the over-all metabolism of carbon dioxide.

The present experiments were designed to obtain quantitative data on $C^{14}O_2$ fixation, from which average body radiation could be calculated. Twelve mice were injected intraperitoneally with a solution containing 2.5 mg of $NaHC^{14}O_3$ and a total activity of 18 μc. The expired CO_2 from all animals was collected over varying intervals, and two mice were sacrificed for organ and tissue analysis at 24 hr, 48 hr, 1 week, 2 weeks, 4 weeks, and 3 months. The C^{14} assays were carried out on pooled blood, spleen, liver, kidney, lung, brain, small intestine, muscle, skin and hair, and bone samples. The procedures used in collecting expired CO_2 and excreta, oxidizing samples, and counting have recently been reported (*6*). The percentage of the total activity retained at a given time was calculated by difference (100% – expired and excreted C^{14}) for the first 24 hr; the activity retained after longer periods was calculated directly from organ, tissue, and fluid weights, and specific activities. These results are presented in Fig. 1. If the amount of C^{14} in the body and the average energy of radiation are known, it is simple to convert such data to roentgen equivalent physical[2] (the basis for radiation tolerance calculations). With the assumption of even distribution, such calculations have been performed with regard to total body radiation and are presented in Table 1. To date we have observed no outstanding selective accumulation of C^{14} from a gross anatomical standpoint.[3] It was observed that the rate of uptake and loss of C^{14} by the jejunum (a rapidly proliferating tissue) was significantly greater

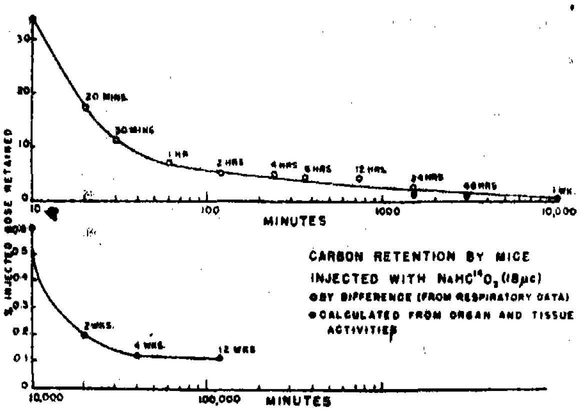

FIG. 1. Carbon 14 retention by mice injected with $NaHC^{14}O_3$.

TABLE 1

BODY RADIATION OF MICE INJECTED WITH $NaHC^{14}O_3$ (18 μc)

	Body C^{14} content (integrated)		Body radiation	
Period	μc	% of injected dose	Total rep period	Average daily rep period
0–60 min	4.8	23.6	0.0250	
1–2 hr	1.12	6.2	0.0058	
2–4	1.00	5.6	0.0104	
4–6	0.92	5.12	0.0090	
6–12	0.86	4.77	0.0266	
12–24	0.54	2.93*	0.0333	
0–24	0.87	4.80	0.110	0.1101
24–48	0.21	1.15	0.053	0.027
1–7 days	0.18	1.00	0.1328	0.022
7–14	0.07	0.41	0.0636	0.009
2–4 weeks	0.03	0.16	0.0496	0.004
4–12	0.02	0.13	0.1613	0.003

* This value is an average of the 12-hr C^{14} level obtained by difference (100% – % expired) and the 1.37% found in the tissues at 24 hr.

Note: Tolerance dose limit for a 24-hr exposure as set by Clinton Laboratories = 0.1 rep.

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[1] This work was carried out for the Atomic Energy Commission under a contract with the Office of Naval Research. Certain data reported herein were obtained in experiments carried out under a grant from the American Cancer Society on recommendation of the Committee on Growth, National Research Council.

[2] One rep or roentgen equivalent physical = 83 ergs/g of tissue. This dose is considered to produce no known effects on man when exposed indefinitely. Factor of safety is probably no more than 2 or 3 (*5*).

[3] The detailed results of these experiments, along with certain calculations as to rate constants having to do with carbon turnover, are being presented elsewhere.

than for other tissues studied. It is obviously necessary to carry this search for specificity into the finer structures of cells, organs, and bone.

When the difference in weight of a man and a mouse is taken into consideration, it is apparent from Table 1 that the average over-all body radiation from bicarbonate C^{14} is apt to be lower than the tolerance level of 0.1 rep per day for man unless high doses are administered (of the order of 5 mc if a safety factor of 10 is assumed for species variation in the biological half-life of bicarbonate C^{14}). It is of course important to study the long term retention of C^{14} from insoluble carbonates and organic molecules which enter the metabolic pathways before being degraded to carbon dioxide, prior to any final conclusions regarding hazard from C^{14}.

Experiments designed to indicate the effects of low doses of $NaHC^{14}O_3$ on the pattern of leukemia in a highly susceptible strain of mice are now under way in this laboratory.

This report should not be construed to suggest at our present state of knowledge an increase in Brues' (*3*) tentative maximum retained dose for man of 30 µc of C^{14}.

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Action of the Venom of Bothrops Atrox on Fibrinogen

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It has been shown by Laki and Mommaerts (*3*) that the conversion of fibrinogen to fibrin takes place in two stages: first, thrombin brings about some change in the fibrinogen molecules, which then polymerize to a clot. These authors have also shown that a solution containing phosphate buffer, pH 5.1, fibrinogen and thrombin, does not coagulate. Clotting occurs only after neutralization of the system with secondary phosphate buffer. The longer the thrombin and fibrinogen are incubated at the acid pH, the shorter the clotting time becomes. This shows that a primary reaction takes place even at pH 5.1, and the polymerization of the primary product, the profibrin, into fibrin takes place only at a higher pH.

The thrombin-like clotting action on blood and fibrinogen of the venom of Bothrops atrox (*1*) has been compared with thrombin under the same experimental conditions as described by Laki and Mommaerts. In these experiments the fibrinogen solution was prepared according to the method of Laki (*2*). As clotting agents, thrombin of Parke and Davis Company, a saline Bothrops atrox solution in a dilution of 1:15,000, and a venom solution precipitated three times with acetone and heated at 50° C for 20 min, were used.

To aliquots of fibrinogen solution brought to pH 5 with phosphate buffer there was added thrombin, or the venom, or the acetone-precipitated venom solution. After various incubation times a part of the reaction mixtures was removed and neutralized with secondary phosphate to pH 7, and the clotting time was measured.

Fig. 1 illustrates the coagulation curves obtained by the three different solutions. It can be seen that venom transforms fibrinogen into profibrin faster than thrombin, but after a certain time the clotting time becomes longer and longer, and finally the neutralized fibrinogen-venom-buffer system does not clot at all. Addition of thrombin to such neutralized solutions does not bring about coagulation, but if fibrinogen is added, clotting takes place. This shows that the reversal of the venom curve is caused by the disappearance of reactive fibrinogen, presumably due to fibrinolysin present in the venom. In the case of acetone-precipitated venom, the reaction is similarly fast, but the clotting time, having reached its lowest value, remains at this level.

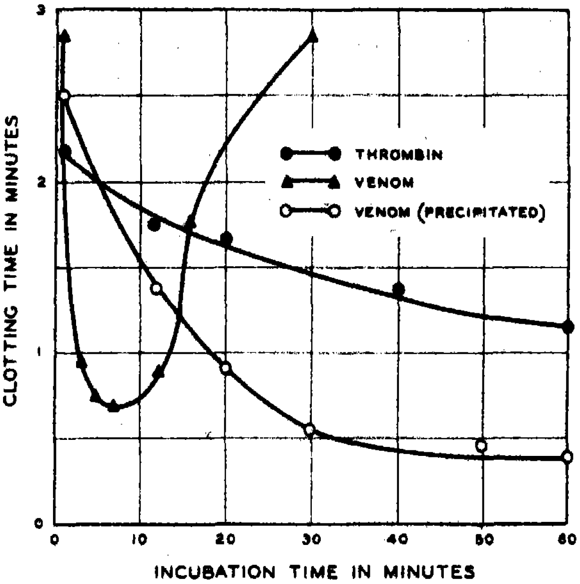

FIG. 1. The effect of incubation time on the clotting of reneutralized fibrinogen solution brought about by the action of thrombin, venom, and precipitated venom.

These experiments with acetone-precipitated and heated venom solutions show that precipitation and heating eliminates, or at least reduces, the fibrinolytic action of venom, and that the clotting action of venom is not only due to its proteolytic activity but to some thrombin-like enzyme. Further details of this work will appear elsewhere.

References

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2. Laki, K. *Stud. Inst. med. Chem.*, 1943, **2**, 27.
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Comments and Communications

Welding Thermocouples

In a recent technical paper (*Science*, March 18, 1949, p. 281) James A. Riley presented "A Simple Method for Welding Thermocouples."

I should like to bring to your attention a description of a similar apparatus invented in Russia by a member of the "Vnidi," Engineer Velixon, for making pyrometers to be used on engine pistons. The usual couples, consisting of copper, constantan, nickel, and nichrome, cannot be used for such purposes because of the high incidence of breakage due to the low elasticity of these materials.

The best couple for measurement of the temperatures of high speed Diesel engines (1500 rpm) has been found to be annealed steel and constantan. However, welding of the materials is difficult in an ordinary voltaic arc as the steel oxidizes.

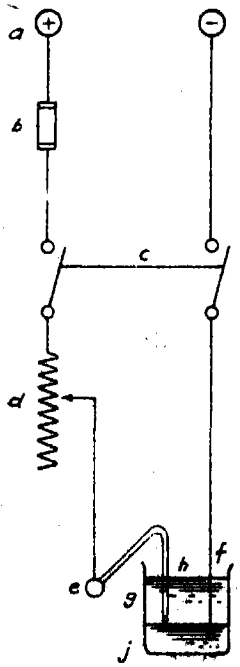

FIG. 1. Velixon apparatus for welding fine wires.

Essential features of the Russian apparatus are shown in Fig. 1, and a description of the process (*Dieselestroyenive*, Nos. 4–5, 1932, p. 38) is as follows:

"One of the poles of the source of current (D.C. is preferable) is connected through fuse b, knife-switch c, and resistance d, to the terminal e. The other pole is connected to a wire dipped into vessel f containing mercury j and oil g. To weld the couple, the ends of the wires are twisted into a knot h, the free end of one of the wires being connected to terminal e. The knot is then dipped into the mercury and rapidly withdrawn. For an instant an arc is formed between the mercury and the wire knot while the latter passes through the oil, and this arc welds the tips of the wires together. An excellent joint is produced as the process takes place in a complete absence of air. Wire of diameter from 0.05 to 2.0 mm. can be welded by this method."

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International Polar Year of 1932–1933

The Second International or Jubilee Polar Year of 1932–1933 was sponsored by the International Meteorological Organization. That organization had also sponsored the First International Polar Year of 1882–1883, as the result of a suggestion made in 1875 by Lieutenant Karl Weyprecht of Austria. Weyprecht's premise that the scientific worth of polar expeditions would be immeasurably increased were they arranged to follow a uniform program to supply simultaneous physical data at many stations in high latitudes, was more than justified by the 20 or more published volumes on the results during 1882–1883.

Advances in all geophysical sciences since 1883, and especially since 1900, indicated that international pooling of resources in instruments, techniques, and methods would be most desirable for any program of polar expeditions, as for example, a second Polar Year of 1932–1933. The preparation of plans for the effort of 1932–1933 was placed by the International Meteorological Organization in the hands of a special International Polar Year Commission, under the presidency of the late Dr. D. la Cour, director of the Danish Meteorological Institute. Dr. La Cour instituted world-wide cooperation in the subject with the result that some 44 countries undertook to participate in the program. Twenty-two of these countries sent out special expeditions, several of which established new stations outside their own borders. In spite of the world-wide economic depression in the early 1930's the necessary funds were found through governmental appropriations and liberal grants from scientific endowments. The polar network of stations was augmented by special programs at existing geophysical observatories in lower latitudes and thus the Second Polar Year was in the truest sense world-wide.

The realization and accomplishment of the program as an international project is a monument to the enthusiasm and indefatigability of La Cour and to the support generously provided by the Danish Meteorological Institute. In spite of interruptions in investigations arising from World War II and the world's unrest in several years preceding that war, many valuable contributions to polar geophysical knowledge have already been made. But there remains much material not yet fully compiled or discussed and many completed or partially completed manuscripts awaiting publication. It would be peculiarly unfortunate if the potentialities for increased understanding of polar geophysics resulting from this great project, in which so many nations and men took selfless part at great cost, were not fully harvested.

The International Meteorological Organization therefore appointed in November, 1946 a special committee to consider and report upon steps to be taken to complete reductions, analyses, discussions, and publications of the results of the Second International Polar Year 1932–1933 within a definite time limit. Following the committee's report of recommendations in Washington, D. C., to the Directors' Conference of the International Meteorological Organization on October 8, 1947, the Temporary Commission on the Liquidation of the Polar Year 1932–1933 of six members (J. A. Fleming [U. S.], J. Keränen [Finland], H. Petersen [Denmark], J. M. Stagg [Great Britain], H. U. Sverdrup [Norway], and A. Thomson [Canada]), was established. The responsibilities of this commission were defined as follows:

(1) *Terminal date.*—Terminal date for completion of all compilations, analyses, discussions, and final publications was set as December 31, 1950.

(2) *Duties of temporary commission.*—The temporary commission was authorized to (*a*) acquire services of scientific men as deemed desirable to effect completion of agenda on or before the terminal date, (*b*) approve expenditures of available funds or of funds made available from any source for necessary services and costs of publications, (*c*) set up a suitable central bureau and repository of all records, materials, and publications of the Polar Year 1932–1933, and of funds, and (*d*) appoint, with the approval of the director of the organization designated to house the central bureau, a part-time or full-time paid executive officer whose duties and responsibilities are to be set by the commission.

(3) *Funds and property.*—The commission is to (*a*) arrange for funds, other than those already available, and to disburse same and (*b*) have prepared a complete inventory of all instruments and property of the Polar Year Commission 1932–1933 showing (1) original purchases and (2) present distribution by gift or loan or in storage, as also to have authority to dispose of all in accordance with urgent needs of geophysical organizations for worthy projects contemplated.

(4) *Bibliography.*—The commission is to have prepared a complete bibliography of microfilms and publications and their availability for distribution.

(5) *Historical summary.*—Investigators seeking material and results concerning the First International Polar Year 1882–1883 have been disappointed not to find anywhere a single-volume published summary of the activities and publications of that enterprise, despite the numerous valuable contributions which came directly from the results. It is of first importance therefore that the commission arrange for preparation, publication, and wide distribution of a comprehensive, authoritative historical summary of the Polar Year 1932–1933, and of suitable condensations thereof for publication in leading scientific journals. This summary should include lists of (*a*) official resolutions relating to the enterprise by reference to published sources and by publication of those so far not published, (*b*) complete lists of organizations taking part and their contributions, and (*c*) complete lists of stations, personnel, equipment, and programs followed.

(6) *Classification for liquidation of agenda.*—The liquidation of the agenda is to be accomplished under four general allocations, namely: (*a*) meteorology and allied results; (*b*) geomagnetism, earth currents, atmospheric electricity and allied results; (*c*) auroral results; and (*d*) aerological results.

Early in 1948, with the approval of the Danish Ministry, the central bureau was set up at the Danish Meteorological Institute, and Dr. V. Laursen of that institute was made executive officer under the immediate direction of Director H. Petersen. Permission was also given for the part-time services of Messrs. J. Olsen and J. Egedal of the institute's staff to be available.

Balance of funds available (some $7,000) was generously supplemented by a final grant of $12,000 from the Rockefeller Foundation through its Board of Trustees, December 2–3, 1947. Of these funds a considerable amount has already been budgeted for various items in the liquidation. As any unexpended balances on December 31, 1950, must be reverted, it is urgently requested that all persons having Polar Year reductions, analyses, and manuscripts in mind will promptly communicate with the executive officer of the Central Bureau at Copenhagen with estimates of funds needed. There are now only some 15 months before the terminal date set by the directives given the commission.

The accomplishment of the program of the Second International Polar Year 1932–1933 was heroic. It would be a calamity and an injustice to those who gave so generously in funds, effort, and time not to see its work completed in respect to thorough compilation, analysis, discussion, and publication as a whole enterprise. The commission will be glad to hear from anyone who may already have published results (with full bibliographical particulars) or who may have some further research in mind, either partially completed or planned, based on data obtained during the Second International Polar Year. Any work to be undertaken must be completed and published by the terminal date set—December 31, 1950.

The completion of what was in the largest sense a distinctly cooperative and international effort, must insure general coordination of findings and their consideration in the broadest aspects. It will provide almost unlimited sources of observed and reduced data for the benefit of scientific investigations for many years to come in which uniform and world-wide simultaneous material is needed.

TEMPORARY COMMISSION ON LIQUIDATION
OF POLAR YEAR 1932–33
J. A. Fleming, President
Carnegie Institution of Washington
V. Laursen, Executive Officer,
Danish Meteorological Institute, Copenhagen

Correction

Professor A. N. Winchell, of the University of Virginia, has called our attention to some inconsistencies in our paper "Crystalline Salts of Dihydrostreptomycin" (*Science*, 1949, 109, 515). In the section describing the microscopic examination of crystalline dihydrostreptomycin sulfate, the following correction should be made: Lines 30 and 31 should read: "2V (calculated) 89°; *extinction*, parallel and/or oblique; *extinction angle* 18°" instead of "2V (calculated) − 89°; *extinction*, parallel; *extinction angle* − 18°."

Frank J. Wolf, Eleanor T. Elmendorf
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The Zoological Station of Naples

The Zoological Station survived the war without heavy damages. The laboratories and library lost some apparatus and books, but the building was not seriously damaged. The devotion of the personnel and the intelligent cooperation of allied military authorities are the main factors responsible for this fortunate circumstance. A short chronicle of what happened to the Naples Zoological Station during the war and the years of military occupation has been published by the writer in the first issue of the *Publicazioni della Stazione Zoologica di Napoli* (1946, 20, pp. 75–86).

Since that time, fortune and numerous friends throughout the world have assisted the director, Prof. R. Dohrn, and his staff in their task of completely rehabilitating the old institute. Three reports have been published on the activity of the station (*Pubbl. Staz. Zool.*, 1946, 20, pp. 87–89, covering the years 1943–45; 1947, 21, No. 2, pp. I–VII; and 1949, 21, No. 3, pp. I–VI). During the years 1943–46 only 11 scientists worked at the station besides the staff. In 1947 there were 57; in 1948, 33 Italians and 28 foreigners, a total of 61. Foreigners (1947–48) are distributed as follows: England, 14; Switzerland, 12; Sweden, 6; Holland, 4; U.S.A., 4; Belgium, France, Spain, 2 each; Chile, China, Denmark, Germany, Greece, India, Hungary, Turkey, 1 each.

The work done by the various scientists covers a wide field, including ecology and systematics, parasitology, descriptive and experimental histology, cytology, descriptive and experimental embryology, chemical embryology, biochemistry, chemistry and biology of fertilization, physiology of the nervous system, sex problems, invertebrate endocrinology, radioactive isotopes, etc. Some laboratories, e.g. the Wenner-Grens Institut Stockholm (director, Prof. John Runnström) have sent to Naples an entire research staff to work on specific problems and to collect material to be studied at home.

The equipment of the station has improved considerably, but extremely specialized and expensive items such as ultracentrifuge, Tiselius electrophoresis, or Casperson's U.V. apparatus, are lacking. Such apparatus as constant low temperature rooms, freeze-drying apparatus, ultrathermostats, photoelectric colorimeter, Geiger counter for radioactive isotopes, Beckman spectrophotometer, cathodic rays oscillograph, and phase contrast microscope have been secured.

The library is also in very good shape. The gaps in the files of journals have been almost entirely filled, and subscriptions are running regularly. This is most important, since so many biological laboratories in Europe have been destroyed. The collection of reprints is also increasing greatly. All biologists are urged to send their reprints regularly to the Library of the Zoological Station. The papers will become known to a wide circle of scientists. Many students are attracted not only by its laboratories and working possibilities, but also by its library.

It would be impossible to mention here all the people and organizations who have helped and are still helping the institution towards its rehabilitation. The cooperation of these friends from all over the world has been the directorial staff's greatest reward.

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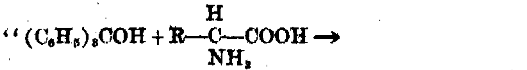
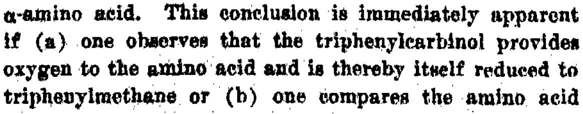
Oxidation vs. Reduction of an α-Amino Acid

In a recent paper in *Science* (1949, 109, 547) Schönberg and Moubasher proposed to connect the bacteriostatic or spermatocidal actions of substances related to benzil, of quinones, of triphenylcarbinol, etc. to their abilities to "reduce" α-amino acids. As illustrative of this process of "reduction" of an α-amino acid, these authors gave the equation,



$$``(C_6H_5)_3COH + R-\overset{H}{\underset{NH_2}{C}}-COOH \rightarrow (C_6H_5)_3CH + RCHO + NH_3 + CO_2.''$$

In order to prevent further confusion in the chemical literature, I should like to point out that this process represents the oxidation (and not the reduction) of an α-amino acid. This conclusion is immediately apparent if (a) one observes that the triphenylcarbinol provides oxygen to the amino acid and is thereby itself reduced to triphenylmethane or (b) one compares the amino acid with its degradation products via the formal representation,



$$R-\overset{H}{\underset{NH_2}{C}}-COOH \xrightarrow[-NH_3]{+H_2O} R-\overset{H}{\underset{OH}{C}}-COOH \xrightarrow{-CO_2} RCH_2OH \xrightarrow{-2H} RCHO$$

in which one of the steps is seen to involve dehydrogenation, i.e., oxidation. It is, moreover, difficult to visualize how benzils or quinones could readily function as reducing agents rather than oxidizing agents.

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Book Reviews

Traité de Zoologie: Anatomie, Systématique, Biologie: Échinodermes, Stomocordés, Procordés. (Tome XI.) Pierre-P. Grassé. (Ed.) P. Brien, M. Caullery, L. Cuénot, A. Dalcq, C. Dawydoff, P. Drach, H. Harant, and G. Waterlot. (Contribs.) Paris (VI): Masson et Cie., 1948. Pp. 1077. (Illustrated.) 3800 fr.

There is always a need, in every branch of science, for up-to-date, authoritative, and comprehensive summaries of knowledge. In the field of descriptive zoology the wealth of new information that was amassed at the turn of the century made the task of compiling such treatises a difficult one, because they frequently became outdated before they were finished. In recent years, since the majority of zoologists have turned their attention towards experimental studies, the time has been better suited to the preparation of such works, which may now be written with reasonable assurance that they will remain useful for many years before extensive revision becomes necessary.

The publication of Miss Hyman's *The invertebrates: protozoa through ctenophora* in 1940 was an event of importance. It was the first attempt in the English language to summarize the existing knowledge of the invertebrates since the unfinished work of Lankester some forty years before. The publication under review is of similar importance, and serves to replace and extend such works as Delage and Herouard's *Traité de zoologie concrète* (1896–1903).

Tome XI is the first of a total of seventeen volumes planned for the series, which will cover the entire animal kingdom. The eight contributors are well chosen for the sections assigned to them and are known for their original contributions to the groups of animals concerned. The entire work is to be shared among a distinguished body of about eighty authors.

Illustrations are adequate in number and in clarity, being, for the most part, original or redrawn from original sources. In spite of the difficulties inherent in this type of collaboration, the editor is to be congratulated upon the consistency of style, and the authors upon the clarity of language. It is a pity that the arrangement of material within each phylum varies somewhat with the different authors. The use of the word *Stomocordés* in place of *Hémicordés* is an example of several innovations that may not receive universal approval, but these minor criticisms are far outweighed by the general excellence of the book.

Further volumes due to appear in 1949 are Tome VI (Onychophores, Tardigrades, Arthropodes: généralités, Trilobitomorphes, Chélicérates), Tomes IX and X (Insectes) and Tome XII (Vertébrés: généralités). These and further volumes will be awaited with interest.

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Aviation medicine in its preventive aspects: an historical survey. John F. Fulton. London-New York: Oxford Univ. Press, 1948. Pp. viii + 174. (Illustrated.) $3.50.

A series of lectures delivered by the author at the London School of Hygiene and Tropical Medicine in 1947 provide the substance of this book. Dr. Fulton's long and intimate association with the field and his broad experience are reflected in the informative and authoritative contents. His scholarly style appeals alike to the initiate and to the layman.

The title is hardly specific. For aviation medicine has been, all along, a thoroughly practical branch of applied medicine and physiology and, as such, has always stressed the preventive aspects. The subtitle is more indicative of the subject matter. It is the author's labors in tracing the beginnings of aviation medicine back to Hooke, Boyle, Priestley, Lavoisier, Bert, and others of the 17th, 18th, and 19th centuries and even farther back, with accounts of early animal experiments and observations on humans in mountain climbing and balloon ascents, that will make the book particularly interesting and valuable to workers in the field.

The first three chapters are devoted to effects of abnormal barometric pressure—the first to anoxia, the second to effects of reduced pressure *per se* (bends, chokes), and the third to very rapid reductions of pressure (explosive decompression). The first two subjects are developed historically; the third was evidently not considered by early investigators. The rich opportunity for discussing preventive aspects, particularly in the first chapter, are not exploited, no mention being made, for example, of the long series of basic respiratory studies conducted in the U. S. Air Force laboratories that resulted in successful preventive techniques for altitudes to 40,000 feet and above. There is also no mention, except in the references, of the explosive decompression studies of Major H. M. Sweeney, whose name will always be associated prominently with this subject by his co-workers.

The fourth chapter gives a good, brief account of the physiological effect of acceleration. The important case of acceleration, too brief to produce displacement of blood (as in ejection seats, etc.), is not discussed. It is gratifying to note that the studies of RAF Wing Commander W. K. Stewart, which preceded all the U. S. centrifuge experiments, are given full recognition.

The fifth and final chapter is devoted to problems of crash injury.

In a dissertation which manages to have its say in a modest 170 pages, some omissions are unavoidable. By no means all of the important omissions, however, are alluded to in the preface, so that the uninitiated reader may receive a less than well-balanced impression of the subject. Of the three broad classical fields of investigation in aviation medicine—extremes of temperature, low barometric pressure, and acceleration—the first is not even mentioned, in spite of the fact that it has always been a major concern of aviation physiologists. Night vision, pilot training, and sanitation are mentioned in the preface as important omitted topics. To this list might have been added: numerous other vision problems, human sizing problems in the design of aircraft, controls, and clothing, medical problems caused by noise and vibrations, and the whole broad field of the psychology of flight.

There are few errors for a first edition. On page 61, there is an obvious confusion of absolute and gauge pressures, and on page 123, centripetal and centrifugal forces are respectively correlated, erroneously, with footward and headward forces. On page 124, the starting acceleration of the German V-2 rocket is given as 20 to 40 *G*. Actually, the acceleration is maximum when the fuel is nearly exhausted and does not exceed 8 *G*.

Carefully selected references add to the value of the book, but even here certain omissions are obvious. There is, for example, not one reference, on the subject of acceleration, to the important work of the Aero Medical Laboratory group.

With due regard for the fact that, as the author points out in the preface, the book is an account mainly of his own fields of interest and experience, it may be highly recommended to aeromedical specialists because of its historical perspective, and to the layman as an authoritative and easily read introduction to certain parts of the subject.

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University of Illinois

Syphilis: its course and management. Evan W. Thomas. New York: Macmillan, 1949. Pp. xix + 317. (Illustrated.) $5.50.

In both theory and application, the treatment of syphilis has undergone revolutionary change in the past fifteen years, leaving the subject in great need of adequate summarization—a service that is well done in this book by Thomas, who is eminently qualified by virtue of sustained interest and exceptional clinical experience in syphilis. In a field where few fixed judgments are yet justified, Thomas has freely expressed personal opinions, distinguishing clearly between those based on demonstrable facts and those derived from clinical impressions. While therapy is emphasized, the author also discusses the disease's course and clinical features, clearly but briefly—especially in the case of cutaneous and mucosal changes, where he merely points out the adequacy of previous descriptions and the obvious change in type of clinical material seen today in contrast with a few years ago. In spite of its brevity, the book should be adequate for the nonphysician interested in syphilis and for the medical student who has opportunity to learn from observation of clinical material. It will be particularly helpful to general practitioners, and to specialists in training or in practice in the many communities where the incidence of syphilis has decreased so much that it is difficult to arrive at definite conclusions regarding the newer therapeutic modalities. A chapter by Theo. J. Bauer reviews the public health aspects of syphilis.

All phases of syphilis are given consideration, but there is particular value in the discussion of interpreting serologic reactions, with emphasis on quantitative studies, and of neurosyphilis, with emphasis on the Dattner-Thomas concept and the need for repeated examinations of the spinal fluid. With reference to therapy, there is almost complete dependence on penicillin and the author attempts to provide the best available schedules for various clinical and serologic stages of the disease.

Minor criticism might be directed toward the too-brief discussion of the treatment of persons having what are presumably infectious contacts and of congenitally syphilitic women who are pregnant. The relation and association of cancer and syphilis are also treated too briefly, and the use of the term "syphilitic virus" is questionable. In view of Dr. Thomas' attempt at brevity, the space given to reports of individual patients seems unwarranted. The number of radiographic reproductions is greater than is justified by their inferior quality.

FRANCIS W. LYNCH

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Physics: principles and applications. Henry Margenau, William W. Watson, and Carol G. Montgomery. New York: McGraw-Hill, 1949. Pp. x + 760. (Illustrated.) $5.00.

This book has been written to serve as a textbook in a general physics course for sophomore engineering students and natural science majors. A rigorous treatment is presented, with the aim of giving the student a sound basic knowledge of physics that will be adequate for further work in pure or applied physics. The authors assume that the student has a good working knowledge of algebra, trigonometry, and analytic geometry and some idea of the principles of calculus and that he is carrying on further study of calculus concurrently with the physics course.

The rigorous, mature, and stimulating approach to general physics encountered in this text makes it highly suitable for student groups having adequate mathematical preparation and a professional interest in physics. The text is extensive; the authors estimate that they have included enough material for a three-semester course of four or five credit hours per semester. To assist the instructor in choosing material for the usual two-semester course of four or five credit hours per semester, certain sections are starred, to indicate that they may be omitted without interrupting the logical development of the subject or omitting concepts necessary for understanding later sections.

Each chapter contains solutions of well-chosen illustrative examples and is followed by a group of problems for the student to solve. Very few problems can be solved by "substitution in formula"; they demand an understanding of principles and many problems are sufficiently difficult to demand effort from good students.

The text material is organized into sections on mechanics, heat, electricity, sound and light, and modern physics. All frequently used systems of units are introduced with careful explanations, in the hope that the student will be able to work with British and metric gravitational units and British, cgs, and mks absolute units.

VIVIAN A. JOHNSON

Purdue University

Historical geology. Carl O. Dunbar. New York: John Wiley; London: Chapman & Hall, 1949. Pp. xii + 567. (Illustrated.) $5.00.

This book is the successor to the authoritative and successful *Historical geology*, first published by Charles Schuchert in 1915, revised by Schuchert in 1924, and authored jointly by Schuchert and Dunbar in 1933 and 1941. Each edition has been considered the authoritative text on the stratigraphy and paleontology of North America, and was preeminent in the paleogeography of North America, in which subject Charles Schuchert was the world's foremost authority for over thirty years. Invaluable as the paleogeographic maps were, it is rather odd that their importance in size and precision declined through the four editions.

Dunbar's *Historical geology* follows the plan, the substance, and most of the illustrations of the previous editions. An attempt has been made to popularize the text by more general treatment of stratigraphic and biologic facts, by omitting all but one of the stratigraphic correlation tables, and by including many large illustrations which cover from a quarter to half a page. The paleogeographic maps, which in previous editions were the authors' main original contribution to historical geology, have been reduced in effectiveness by purposely obscuring the boundaries of the continent and the limits of the seas by cloud effects, in order to emphasize the lack of knowledge about ancient seas and lands. The chapter on the origin of the earth might well have been reduced in length, for all of the hypotheses discussed are confusing and lack conviction, and are skipped as worthless by many instructors.

Whereas the book has been made more attractive by the emphasis on illustrations, and more readable by being less technical, it has lost a good deal of value as a text and a book of reference by omission of correlation tables, and by the obscuring of the paleogeographic maps. Nevertheless, it is likely to continue to be one of the leading textbooks in historical geology.

J. J. GALLOWAY

Indiana University

Scientific Book Register

ANDERSON, EDGAR. *Introgressive hybridization.* (Wiley Biological Research Series.) New York: John Wiley, 1949. Pp. ix + 109. (Illustrated.) $3.00.

BACHOFEN-ECHT, ADOLF. *Der Bernstein und seine Einschlüsse.* Vienna, Austria: Springer-Verlag, 1949. Pp. 204. (Illustrated.) $4.80.

BLOM, A. V. *Organic coatings in theory and practice.* New York: Elsevier, 1949. Pp. xi + 298. $6.00.

CANNON, DOROTHY F. *Explorer of the human brain: the life of Santiago Ramón y Cajal.* New York: Henry Schuman, 1949. Pp. xv + 303. (Illustrated.) $4.00.

CANNON, WALTER B. and ROSENBLUETH, ARTURO. *The supersensitivity of denervated structures: a law of denervation.* (Experimental Biology Monographs.) New York: Macmillan, 1949. Pp. x + 245. (Illustrated.) $5.50.

CORLISS, JOHN J., FEINSTEIN, IRWIN K., and LEVIN, HOWARD S. *Analytic geometry.* New York: Harper, 1949. Pp. xi + 370. (Illustrated.) $3.25.

DANTCHAKOFF, VERA. *Le Sexe: Rôle de l'hérédité et des hormones dans sa réalisation.* Paris: Presses Universitaires de France, 1949. Pp. 210. (Illustrated.) 480 fr.

EMMONS, WILLIAM H. *et al.* *Geology: principles and processes.* (3rd ed.) New York: McGraw-Hill, 1949. Pp. x + 502. (Illustrated.) $4.50.

FAIRHALL, LAWRENCE T. *Industrial toxicology.* Baltimore: Williams & Wilkins, 1949. Pp. xi + 483. $6.00.

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LEROY, L. W., and CRAIN, HARRY M. (Eds.) *Subsurface geologic methods: a symposium.* Golden, Colo.: Dept. of Publ., Colorado School of Mines, 1949. Pp. 826. (Illustrated.) $6.00 paper; $7.00 cloth binding.

LICHTENSTEIN, BEN W. *A textbook of neuropathology: with clinical, anatomical and technical supplements.* Philadelphia: W. B. Saunders, 1949. Pp. xviii + 474. (Illustrated.) $9.50.

MOLDENKE, HAROLD N. *American wild flowers.* New York: D. Van Nostrand, 1949. Pp. xxv + 453. (Illustrated.) $6.95.

OLIPHANT, M. L. *et al.* *The atomic age.* (Sir Halley Stewart Lectures, 1948). New York: Macmillan; London: Allen and Unwin, 1949. Pp. 149. $2.50.

REDDICK, HARRY W. *Differential equations.* (2nd ed.) New York: John Wiley, 1949. Pp. x + 288. $3.00.

ROTHMANN, S. C. (Ed.) *Construction uses of atomic energy.* New York: Harper, 1949. Pp. vi + 258. (Illustrated.) $3.00.

SCHWEITZER, GEO. K., and WHITNEY, IRA B. *Radioactive tracer techniques.* New York: D. Van Nostrand, 1949. Pp. vi + 241. (Illustrated.) $3.25.

TAYLOR, LEWIS W. (Ed.) *Fertility and hatchability of chicken and turkey eggs.* New York: John Wiley, 1949. Pp. x + 423. (Illustrated.) $5.00.

TITUS, HARRY W. *The scientific feeding of chickens.* (2nd ed., rev.) Danville, Ill.: Interstate, 1949. Pp. 253.

TOBIN, CHARLES E. (Ed.) *Shearer's manual of human dissection.* (2nd ed.) Philadelphia: Blakiston, 1949. Pp. xv + 286. (Illustrated.) $4.50.

TUTIN, JOHN. (Ed.) *Atomic energy yearbook.* New York: Prentice-Hall, 1949. Pp. xvii + 237. (Illustrated.) $3.85.

UNDERWOOD, BENTON J. (Ed.) *Experimental psychology: an introduction.* New York: Appleton-Century-Crofts, 1949. Pp. vii + 638. (Illustrated.) $4.50.

NEWS and Notes

Otto Warburg, for the past six months Special Research Fellow of the National Cancer Institute, returned to Berlin-Dahlen, Germany on September 8 to continue his directorship of the Kaiser Wilhelm Institute for Cell Physiology, established in 1931.

Charles Fore Wilkinson, Jr., associate director of the Division of Medicine of the Kellogg Foundation and assistant professor of medicine at the University of Michigan Medical School, has been appointed professor and chairman of the Department of Medicine of the Postgraduate Medical School, New York University-Bellevue Medical Center.

George A. Lundberg, head of the Department of Sociology at the University of Washington, is giving a series of lectures at the University of Stockholm during September and October. Dr. Lundberg's visit was arranged in cooperation with the Swedish Government Social Research Council. Upon completion of the series, he will lecture at the University of Oslo.

Perihan Cambel, formerly pathologist at the Gureba Hospital, Istanbul, and the Hygiene Institute, Ankara, has resigned his post at the Division of Cancer Research, Washington University, to become a special fellow and research associate professor at the Cancer Research Laboratory, University of Florida.

Max Astrachan, chairman of the Department of Mathematics, Antioch College, has been appointed professor and head of the Department of Statistics, U. S. Air Force Institute of Technology, Wright-Patterson Air Force Base, Dayton. Dr. Astrachan is on leave of absence from Antioch during 1949–50.

Hans Waine, physician and specialist in rheumatic diseases, has been appointed medical director of the New England Chapter of the Arthritis and Rheumatism Foundation, Boston. Dr. Waine will direct the foundation's activities in Massachusetts, Maine, New Hampshire, and Vermont.

Donald B. McMullen, associate professor of preventive medicine and public health, University of Oklahoma Medical School, has returned after 26 months' leave of absence. Dr. McMullen has been working on the epidemiology and control of schistosomiasis japonica in Tokyo, where he has been senior parasitologist with the 406th Medical General Laboratory.

Edwin St. Clair Gantz, associate professor of chemistry, Purdue University, has accepted a position as head of the Analytical Branch of the Chemistry Division, Research Department, at the Naval Ordnance Test Station, Inyokern, California.

Wendell W. Moyer, director of research at the Crown Zellerbach Corporation, Camas, Washington, has been placed in charge of the entire research and development activities of the company. **W. M. Hearon** has been appointed assistant director of research.

Edward Abrams, head of the Biology Division of the Institute of Textile Technology, Charlottesville, Virginia, and former head of the Microbiological and Microscopy Laboratories at the National Bureau of Standards, has established a new organization, Laboratories Research, at Mamaroneck, New York. Dr. Abrams will act as a consultant in the prevention of microbiological deterioration of organic and fibrous materials, stream pollution abatement, and general problems in bacteriology and biochemistry.

George W. Hartmann, Columbia University psychologist, has been appointed professor of psychology at Roosevelt College. Dr. Hartmann is the author of *Educational psychology* and *Gestalt psychology*.

Mr. and Mrs. Edward C. Rustigan are the parents of a baby girl, born September 17, 1949. Mrs. Rustigan is the former Mildred Atwood, who resigned as executive editor of *Science* in 1948.

Visitors to U. S.

Visitors at the National Bureau of Standards during the week of September 5 included **Matti U. Alhopuro**, metallurgical engineer, Autokumpu Copper Mines, Inc., Kumpu, Finland; **Pierre Chavance**, engineer with the Centre National d'Etudes et des Telecommunications, Neuilly, France; **Jean Combrisson**, engineer with École de Physique et Chimie, Paris; **Jacques Dedieu**, research metallurgist with École Centrale des Arts et Manufactures, Paris; **G. M. Gad**, Ceramics Division, Ministry of Industries, Egypt; **Paavo J. Kajanne**, research assistant, Finnish Institute of Technology, Department of Chemistry; **Delia H. Simpson**, professor of physics, Cambridge University; **Jacob Sklarewitz**, research worker, Hebrew Technical College, Haifa, Israel; **Adolf G. Smekal**, professor, Technical University at Darmstadt and member of German Society of Glass Technology; **Albert Sundren**, director of the Peat and Oil Research Laboratory of the State Institute for Technical Research, Helsinki; and **M. D. Waldhorn**, research worker with the Weismann Institute of Science, Rehovot, Israel.

F. C. William, consultant with the Manchester University, England, delivered a series of lectures on the cathode ray memory tube at the National Bureau of Standards Institute of Numerical Analysis at Los Angeles during the week of September 13.

Grants and Awards

The National Heart Institute has allocated $485,000 for heart research at New York University-Bellevue Medical Center. The fund will be devoted to the construction of laboratories and equipment for the center's Institute of Cardiovascular-Renal Disease. The institute's research program will be coordinated by the center's Scientific Committee on Cardiovascular-Renal Disease under the chairmanship of Homer W. Smith, physiologist.

The Howard N. Potts Medals of the Franklin Institute will be presented on October 19 to John W.

Mauchly, physicist, and J. Presper Eckert, Jr., electronic engineer, for their work in the design and construction of the digital electronic computing machine, ENIAC. The design for EDVAC, the electronic computer developed by the University of Pennsylvania, was also suggested by the two scientists.

Fellowships

The National Research Council of Canada will offer 31 postdoctorate fellowships for the year 1950–51, 18 of which will be awarded in chemistry, 3 in atomic energy research, and 10 in physics. The stipend of $2,820 per annum is supplemented by travel grants for successful candidates from abroad. While appointments in the atomic energy project are restricted to Canadian citizens and British subjects, applicants of all nationalities are welcome in the chemistry and physics divisions. Application forms and further information may be obtained from The Secretary, Laboratories Awards Committee, National Research Council, Ottawa. Applications should be received not later than *February 15, 1950*.

The School of Mathematics of the Institute for Advanced Study will allocate a small number of stipends to mathematicians and mathematical physicists for study and research at Princeton during the academic year 1950–51. Candidates must show ability in research comparable with that expected for the Ph.D. degree. Application blanks may be obtained from the School of Mathematics, Institute for Advanced Study, Princeton, N. J., and are returnable by *February 1, 1950.*

Colleges and Universities

Wayne University has received a grant of one million dollars from the Kresge Foundation to erect the Kresge Science Library which will house the university's Kresge-Hooker scientific collection, one of the most comprehensive chemical libraries in the world, as well as other science books and periodicals. There will be stack space for 50,000 science volumes and 900 science periodicals and future accessions; seminar rooms, a lecture hall, and a complete microfilm laboratory. It is expected that the library will be completed in 1951.

The Chemistry Department of the University of Notre Dame has announced its Nieuwland and Peter C. Reilly Lectures in Chemistry for the coming academic year. Eric K. Rideal, director of the Davy Faraday Research Laboratory, the Royal Institution, London, as Nieuwland lecturer, will talk on "Some Aspects of Surface Action," giving two lectures on liquid monolayers October 11 and two on solids October 13.

Lecturers for the Peter C. Reilly series are: Richard A. Ogg, Jr., of Stanford University, on leave as visiting lecturer at Harvard, who will talk on an unannounced topic during the week of October 31; Frederick D. Rossini, chief, Section on Thermochemistry and Hydrocarbons, National Bureau of Standards, who will deliver six lectures on "Chemical Thermodynamics and Purification of Hydrocarbons" during the two weeks beginning November 28; and V. Prelog, of the Eidge. Technische Hochschule, Zurich, who will visit the university for seven weeks beginning February 12, 1950, to discuss work in progress in his laboratories on "Ring Formation and Ring Properties," and various natural products.

The newly established New South Wales University of Technology, Sydney, Australia, is now offering undergraduate degrees in civil, electrical, mechanical, and mining engineering, applied chemistry, and chemical engineering, and graduate work in electronic engineering. Further degree courses will be established in 1950. The first university building is now being erected at Kensington. The following appointments to foundation chairs have already been made: chemical engineering, J. P. Baxter; mining engineering, D. W. Phillips; electrical engineering, H. J. Brown; architecture, F. E. Towndrow, and applied chemistry, A. E. Alexander.

Meetings and Elections

The American Psychological Association held its 1949 meeting in Denver, Colorado September 5–10. Morning and afternoon sessions were mainly devoted to research papers and symposia. These demonstrated the wide variety of research interests of psychologists, since they ranged in title over such topics as "Brain Functions," "Personality and Psychotherapy," and "Methodology in Social Psychology." The increased demand for psychologists and the necessity for training greater numbers of students to the Ph.D. level resulted also in many programs on the professional aspects of psychology.

Ernest R. Hilgard, of Stanford University, gave his presidential address on "Human Motives and the Concept of the Self." He suggested that psychologists begin formal research on the problems of personality and that one method of attaining this goal would be the establishment of "psychodynamic laboratories." There has been a lack of systematic treatment of psychodynamic problems, he stated, and "when there is no effort to be systematic, problems are not sharply defined."

Other evening addresses were delivered by Douglas McGregor, president of Antioch College, on "Labor-Management Relations: A Challenge to the Social Scientist," and William Menninger, past president of the American Psychiatric Association, on "Relations between Psychiatry and Clinical Psychology."

An innovation in the 1949 program was an evening free of formal sessions. About half of the 1,850 registrants took advantage of the opportunity to attend a buffalo barbecue at the Red Rocks Theater, in the Rockies a few miles west of Denver, during this time.

An award offered by an anonymous donor for the best paper published during 1948 in one of the association's journals was presented to L. L. Thurstone of the University of Chicago, for his paper in the *American Psychologist* entitled "Psychological Implications of Factor Analysis." Honorable mentions were given four papers by Thales Martins and J. R. Valle, Neal E. Miller, Edward C. Tolman, and Herman A. Witkin and Solomon E. Asch.

The annual Edward L. Bernays award was presented by Mr. Bernays to the Commission on Community Interrelations of the American Jewish Congress for their studies on bigotry. The award was accepted for the commission by Stuart W. Cook, director of research, and Alfred Marrow, chairman of the Research Board.

J. P. Guilford, of the University of California, is the new president of the American Psychological Association. Robert R. Sears, of Harvard University, was elected president-elect, and Dorothy Adkins, of the University of North Carolina, recording secretary. New members of the Board of Directors are John G. Darley, University of Minnesota; J. McV. Hunt, Institute of Welfare Research, Community Service Society of New York; and E. Lowell Kelly, University of Michigan. At the annual business meeting, the 1951 and 1952 meetings were scheduled for Chicago and Washington, D. C. respectively. Next year's meeting will be held on the campus of Pennsylvania State College September 3–9.

DAEL L. WOLFLE

It may truly be said that the science of biochemistry came of age when the **First International Congress of Biochemistry** met August 19–25 in Cambridge, England.

A year or two ago the Biochemical Society of England queried leading biochemists to obtain their reactions to the proposal to hold such a congress, and on the basis of response they decided to hold the congress in Cambridge under the presidency of A. C. Chibnall, F.R.S., professor of biochemistry of the university. An executive committee was set up and plans laid. By the summer it was clear that attendance would be large; it ultimately reached 1,750 individuals from 42 nations. There was a large and imposing American delegation and very large French and South American attendance. Scandinavia was also well represented.

As Cambridge has only five hotels, arrangements were made with the colleges for use of their rooms. We heard many comments on the spartan life of the undergraduates. Most participants, however, found their experience of student life at an old university interesting.

The opening ceremony, held in the historic Senate House where Winston Churchill was given an honorary degree, was packed, with many members standing. In the same hall, the degree of Doctor of Science *Honoris causa* was conferred on half a dozen of the world's leading biochemists including Carl Cori, Nobel Laureate and professor at Washington University. The old-fashioned ceremony, conducted entirely in Latin, preceded and followed by the Procession of Doctors through the town, will be long remembered by those privileged to see it.

After the degree ceremony there was a garden party in the grounds of St. John's College. The British Government invited all members to an evening reception on the grounds of Trinity College. It was also in the Great Hall of Trinity that the president's dinner was held for distinguished overseas members.

The 12 sections of the congress were in almost continuous session and over 500 papers were read and discussed. The highlights of the scientific meetings, however, were the three congress lectures. The first was given by C. T. Cori on "The influence of hormones on enzymatic reactions," the second by M. Florkin on "Biochemical aspects of some biological concepts," and the third by Sir Robert Robinson, also a Nobel Laureate, on "Tryptophan and its structural relatives."

At the formal closing session in the Senate House, the president thanked those who had worked so hard and the authorities of the university. He invited Sir Charles Harington, director of the National Institute for Medical Research and chairman of an *ad hoc* international committee, to report on the findings of the committee set up to consider the future of the congress.

The committee unanimously recommended that the Second International Congress of Biochemistry meet in Paris in 1952 at the invitation of the Société de Chimie Biologique and that immediate steps be taken to establish an International Union of Biochemistry under the wing of the International Council of Scientific Unions. Both these recommendations were passed.

The congress was privileged to witness a demonstration of Scottish sword dancing and reels to the music of Pipe-Major Robert Hill in his magnificent tartan and kilt.

FRANCIS J. GRIFFIN

Over 30 delegates from five foreign countries and the U. S. attended the **First International Sesame Conference** held at Clemson College, South Carolina, August 15–16.

A paper of preliminary work with sesame in El Salvador by Juan Cano, of Centro Nacional de Agronomia, was presented at the opening session by James Watkins, of the Office of Foreign Agricultural Relations mission in El Salvador who stated that sesame production in El Salvador has increased from 9,545 bushels in 1945 to 201,000 bushels in 1948. Much of the seed was exported last year to Italy and Austria under the Marshall Plan. The improvement of the sesame crop in India was discussed in a paper by N. Parthasarthy, head of the Division of Botany, Indian Agricultural Research Institute, New Delhi, presented by N. K. Sen, Division of Genetics of the University of California.

Significant advances in sesame breeding in Venezuela were reviewed by D. G. Langham, who discovered the first nonshattering sesame plant as a result of some of his crosses of breeding lines. Dr. Langham is head of the Department of Genetics and Agronomy of the Venezuelan Ministry of Agriculture.

J. A. Martin, host of the conference and an associate horticulturist of the South Carolina Experiment Station, reported on the breeding work now being done in his state. He has found that sesame is well adapted to the climate and soils of South Carolina and that high yields may be obtained by the use of certain varieties. Dr. Martin pointed out that the seed-shattering characteristic, the main obstacle to commercial production of the crop in this country, is being rapidly overcome.

Delegates were taken on a tour of the greenhouses and fields where sesame was in both the blooming and fruiting stages, and were shown the sesame introductions from foreign countries, breeding lines, yield tests, irradiated lines, weed control experiments, and disease- and wilt-resistance studies.

Properties of a solvent-extracted sesame oil were discussed by K. S. Markley, head of the Oil, Fat, and Protein Division of the Southern Regional Research Laboratory, New Orleans, during the second session of the conference. A paper on the physical and chemical properties of the oils from varieties of sesame was prepared by Pierre Budowski and F. G. T. Menezes, of the Southern Regional Research Laboratory. Sesamol, a constituent of sesame oil, was explained by Dr. Budowski, who also described some of the research work now being done with sesame oil.

The nutritional value of sesame was discussed by Werner G. Jaffe, Sección de Quimica de Nutricion, of the Venezuelan Ministry of Agriculture. The nutritive value of tortillas and pancakes made of corn meal may be increased tremendously by using one part of sesame meal to nine parts of corn meal. Its vitamin values were discussed by E. J. Lease, nutritionist of the South Carolina Experiment Station.

It was pointed out during the meeting that expansion of the breeding program had been greatly facilitated by the research grants-in-aid or fellowships presented by the National Cottonseed Products Association to the Texas State Research Foundation, the North Carolina Experiment Station, and the South Carolina Experiment Station. The cooperative work of F. E. Johnstone, Jr., former chief agronomist of the National Cottonseed Products Association, and Lawrence C. Curtis, chief agronomist of the association, in obtaining seed stocks of various strains and in bringing in new literature on sesame was also commended by the conference. The need for further agricultural research was stressed, along with plant exploration in those countries where sesame has been grown for centuries, to seek superior germ plasm for new breeding lines.

At the final session the delegates accepted an invitation of the government of Venezuela to hold their next annual conference there. In 1950 conference delegates will be given the opportunity of seeing at first hand the research work now being performed by Dr. Langham.

HANS M. SIMONS, JR.

An international symposium on high altitude biology will take place in Lima, November 23–30, under the auspices of Unesco and the government of Peru. The Governing Council of the Institute of Andean Biology, headed by Carlos Monge M., has been appointed organizing committee of the symposium. Papers will be presented on circulation at rest and during physical activity; blood and respiratory characteristics at rest and during physical activity; nervous function; and endocrine factors and reproductions. Papers dealing with general or restricted aspects of the influence of a low environmental pressure on human and animal organisms will be considered by the committee and should be received not later than *October 15*. Hotel reservations should also be made before October 15. Address all communications to the Organizing Committee of the International Symposium on High Altitude Biology, Dr. Carlos Monge M., Director, Institute of Andean Biology, Lima, Peru.

The Tenth International Ornithological Congress, by invitation of the Swedish Ornithological Society, will be held at Upsala, Sweden from June 10 to 17, 1950. Attendance is open to persons of all countries interested in any phase of ornithology. According to the preliminary program the congress will convene in a general session on Saturday, June 10 at 2:00 p.m. Several excursions from Lund are planned for June 3–9, and others will leave from Upsala June 20–July 3. Alexander Wetmore, secretary, Smithsonian Institution, Washington, D. C., is president of the congress and Sven Hörstadius, Zoologiska Institutionen, Upsala, is secretary. Applications for registration should be addressed to the Tenth International Ornithological Congress, Upsala, Sweden, before *February 28, 1950*.

The Virginia Academy of Sciences elected the following officers for 1949–50 at its 27th annual meeting held in Richmond this spring: Boyd Harshbarger, president; Guy W. Horsley, president-elect; Foley Smith, secretary-treasurer; and E. C. L. Miller, secretary-treasurer emeritus. Ladley Husted and John N. Buck were elected to the council. The Academy voted to reestablish *The Virginia Journal of Science*, which was discontinued at the beginning of the war.

The American Neurological Association elected the following officers for 1949–50 at its 74th annual meeting held in June in Atlantic City: president, Henry W. Woltman; first vice president, Johannes M. Nielsen; second vice president, E. Jefferson Browder; secretary-treasurer, H. Houston Merritt; and assistant secretary, Charles Rupp.

Representatives of the atomic energy agencies of Canada, the United Kingdom, and the U. S. will hold their third declassification meeting September 26–28 at the Canadian Atomic Energy Research Establishment at Chalk River, Ontario. The uniform declassification guides, which the three nations now use in determining what information may be published, will be reviewed at the meeting in order to maintain maximum security of information held in common by the three nations. Senior reviewers for the U. S. AEC declassification system are: W. C. Johnson, chairman of the Department of Chemistry, University of Chicago; W. F. Libby, professor of chemistry, University of Chicago; J. M. B. Kellogg, leader, Physics Division, Los Alamos Scientific Laboratory; and R. L. Thornton, professor of physics, University of California.

The New York Academy of Medicine announces that the 1949–50 Laity Lectures will be held at the academy on the following dates: September 28: *Frontiers in Psychiatry*—Franz Alexander, director, Institute for Psychoanalysis, Chicago: October 26: *Methuselah—Myth or Promise*—David Seegal, professor of medicine, Long Island College of Medicine; November 16: *Frontiers* *in Genetics*—Laurence H. Snyder, dean of the Graduate College, University of Oklahoma; December 7: *Machines that Work Like Men*—John H. Gibbon, Jr., professor of surgery, Jefferson Medical College, Philadelphia; January 11: *The Biology of the Antibiotics*—Selman A. Waksman, professor of microbiology, Rutgers University; January 25: *Concepts and Methods of Medical Research*—Thomas M. Rivers, director, Hospital of the Rockefeller Institute for Medical Research. All lectures will be held at 8:30 p.m. The public is invited to attend, admission free. The lectures will be published by the Columbia University Press, New York 27.

A committee on research in anthropology has been formed by the Division of Anthropology and Psychology of the National Research Council and includes the following members: W. M. Krogman, chairman, Graduate School of Medicine, University of Pennsylvania; G. T. Bowles, NRC; W. W. Greulich, Stanford University; W. W. Howells, University of Wisconsin; F. E. Randall, Climatic Research Laboratory, Lawrence, Massachusetts; A. H. Schultz, Johns Hopkins University; H. L. Shapiro, American Museum of Natural History; T. Dale Stewart, U. S. National Museum; and S. L. Washburn, University of Chicago. The committee will serve as a clearinghouse for all research projects involving procedures and techniques of physical anthropology and in this sense will act as an advisory body. Suggestions or requests for advice or aid may be sent to the chairman.

The current ***Progress Report of Brookhaven National Laboratory*** (BNL-AS-2), which combines administrative and scientific progress, January 1 through June 30, 1949, is now available. Requests for this report should be directed to the Information Group, Information and Publications Division, Brookhaven National Laboratory.

Representatives from the anatomy departments of the nineteen veterinary schools in the U. S. and Canada met at the recent convention of the American Veterinary Medical Association at Detroit and formed an **American Association of Veterinary Anatomists.** The purpose of the association is to promote interest in the fields of teaching, research, and publication in veterinary anatomy. Officers of the group are: president, J. A. Grossman, Ohio State; president-elect, M. E. Miller, Cornell University; secretary-treasurer, J. F. Smithcors, Michigan State College.

The First Conference of Research and Development Groups of the Fifth Army Area was held at Fort Sheridan, Illinois, August 27–28. A series of seminars in the physical, biological, and medical sciences and engineering were attended by representatives of the Army's Logistics Division and six of its technical branches, and over 200 reserve officers from 19 research and development groups in the Fifth Army area. The reserve officers were Midwestern scientists representing university faculties, industrial research organizations, and research foundations. The conference was organized at the suggestion of Lars H. Sjodahl, commanding officer of the 5008th Research and Development Group of Chicago, and rheologist with the International Printing Ink Division of Interchemical Corporation.

Deaths

José de Carvajal-Forero, 51, X-ray expert, died August 3 in New York City. Dr. Carvajal-Forero was founder and first president of the New York X-ray Technological Society. He was well known for his technical advances in blue-tinting and work with barium.

Dennis R. Hoagland, 65, one of the country's leading plant physiologists, died September 5 at his home in Berkeley, California. Professor emeritus of plant nutrition and chemistry at the University of California, Dr. Hoagland had headed the university's Division of Plant Nutrition from 1921 until his retirement last June. In 1930 he received the Stephen Hales Prize of the American Society of Plant Physiologists and in 1941 was awarded the AAAS prize for a paper on nutriment solutions of plants, written jointly with Daniel I. Arnon.

Ralph R. Parker, 61, entomologist, died of a heart attack at his home in Hamilton, Montana, September 4. Director of the Rocky Mountain Laboratory of the National Institute of Health, Dr. Parker was codiscoverer of a vaccine for Rocky Mountain spotted fever.

Recently Received—

Etude des propriétés fondamentales des actinomètres by L. Bossy and R. Pastiels. (Memoires, Vol. XXIX. Verhand Elingen, Dl. XXIX). Institut Royal Météorologique de Belgique, Uccle, 3, Belgium.

Transactions of the Royal Society of South Africa, 1949. Copies obtainable from Hon. Secretary, Royal Society, University of Cape Town, Rondebosch, South Africa at 1£ 1s.

Marihuana in Latin America: The Threat It Constitutes by Pablo Osvaldo Wolff. Available from Washington Institute of Medicine, Washington 6, D. C. $1.50.

New Zealand Journal of Science and Technology, Index to Volumes 1 to 25, compiled by V. J. Wilson. (Council of Scientific and Industrial Research.) Direct inquiries to Govt. Printer, Wellington, New Zealand.

Make Plans for—

National Metal Congress and Exposition, 31st annual meeting, October 17–21, Public Auditorium, Cleveland Ohio.

American Oil Chemists' Society, fall meeting, October 31–November 2, Edgewater Beach Hotel, Chicago.

Pacific Chemical Exposition and **Pacific Industrial Conferences,** sponsored by the American Chemical Society, November 1–5, Civic Auditorium, San Francisco.

The Meaning and Limits of Exact Science

Max Planck

EXACT SCIENCE—what wealth of connotation these two words have! They conjure up a vision of a lofty structure, of imperishable slabs of stone firmly joined together, treasurehouse of all wisdom, symbol and promise of the coveted goal for a human race thirsting for knowledge, longing for the final revelation of truth. And since knowledge always means power, too, with every new insight that man gains into the forces at work in nature, he always opens up also a new gateway to an ultimate mastery over them, to the possibility of harnessing these natural forces and making them obey his every command.

But this is not all—or even the most important part of it. Man wants not only knowledge and power. He wants also a standard, a measure of his actions, a criterion of what is valuable and what is worthless. He wants an ideology and philosophy of life, to assure him of the greatest good on earth—peace of mind. And if religion fails to satisfy his longing, he will seek a substitute in exact science, I refer here merely to the endeavors of Monism, founded by outstanding scholars, philosophers, and natural scientists, a school of thought which commanded high respect only as recently as a short generation ago.

Yet, in these our days hardly a word is being heard about the Monists, although the structure of their ideology was unquestionably erected to endure for a long time to come, and it started out on its career with high hopes and great promises. There must be something wrong somewhere! And in fact, if we take a closer look and scrutinize the edifice of exact science more intently, we must very soon become aware of the fact that it has a dangerously weak point—namely, its very foundation. Its foundation is not braced, reinforced properly, in every direction, so as to enable it to withstand external strains and stresses. In other words, exact science is not built on any principle of such universal validity, and at the same time of such portentous meaning, as to be fit to support the edifice properly. To be sure, exact science relies everywhere on exact measurements and figures, and is therefore fully entitled to bear its proud name, for the laws of logic and mathematics must undoubtedly be regarded as reliable. But even the keenest logic and the most exact mathematical calculation cannot produce a single fruitful result in the absence of a premise of unerring accuracy. Nothing can be gained from nothing.

No phrase has ever engendered more misunderstanding and confusion in the world of scholars than the expression, "science without presuppositions." It was coined originally by Theodor Mommsen, and meant that scientific analysis and research must steer clear of every preconceived opinion. But it could not mean, nor was it intended to, that scientific research needs no presuppositions at all. Scientific thought must link itself to something, and the big question is, *where*. This question has occupied the minds of the most profound thinkers of all epochs and all nations, since time immemorial, from Thales to Hegel, setting in motion all forces of man's imagination and logic. But it has been demonstrated again and again that a final, conclusive answer cannot be found. Perhaps the most impressive proof of this negative finding is that until now all attempts have failed to discover a world view uniformly acceptable, in its general features at least, by all minds capable of judgment. The only conclusion which this fact permits, according to every dictate of reason, is that it is absolutely impossible to place exact science in an a priori manner on a universal foundation possessing a fixed and inclusive content.

Thus, at the very outset of our quest for the meaning of exact science, we are confronted by an obstacle which must be a disappointment to everybody who is seriously striving for knowledge. In fact, this obstacle has driven many a critically disposed thinker to join the ranks of the skeptics. And a no less regrettable fact is that there are perhaps just as many, or even more, individuals of the opposite disposition whom the fear of falling victim to skepticism—an ideology which they consider intolerable—drives to look for salvation from prophets of creeds like, for instance, anthroposophy. Such prophets appear on the scene in all epochs, not excepting our own, with their brand new message of salvation, and they often succeed, with an amazing rapidity, in gathering a following of enthusiastic disciples, eventually to make their exit from the stage and to sink back into the all-engulfing abyss of oblivion.

Is there a way out of this fatal dilemma? And where can it be found? This is the first question to claim our attention. I shall attempt to show that there is a positive answer to it, and that this answer will cast a light both on the meaning and limits of exact science. I submit to the judgment of each of you the validity of my proposed resolution of the problem.

I

If we seek a foundation for the edifice of exact science which is capable of withstanding every criticism, we must first of all tone down our demands considerably. We must not expect to succeed at a stroke, by one single lucky idea, in hitting on an axiom of universal validity, to permit us to develop, with exact methods, a complete scientific structure. We must be satisfied initially to discover some form of truth which no skepticism can attack. In other words, we must set our sights not on what we would like to know, but first on what we do know with certainty.

Now then, among all the facts that we do know and can report to each other, which is the one that is absolutely the most certain, the one that is not open even to the most minute doubt? This question admits of but one answer: "That which we experience with our own body." And since exact science deals with the exploration of the outside world, we may immediately go on to say: "They are the impressions we receive in life from the outside world directly through our sense organs, the eyes, ears, etc." If we see, hear, or touch something, it is clearly a given fact which no skeptic can endanger.

To be sure, we speak also of illusions, but never with the intention of implying that the sense perceptions involved are incorrect or even questionable. For instance, when a person happens to be deceived by a mirage, the fault lies not with his perception of the visual image, which is actually present, but in his inferences which draw false conclusions from the given sensory data. The sensory impression is always a given fact, and therefore incontestable. What conclusions the individual attaches to it, are another story, which need not concern us for the time being. Therefore, the content of the sensory impressions is the most suitable and only unassailable foundation on which to build the structure of exact science.

If we call the sum total of sensory impressions "the sense world," we may state briefly that exact science issues from the experienced sense world. The sense world is that which, so to speak, furnishes science with the raw material for its labors.

However, this seems to be a very meager result. For the content of the sense world is, in any case, only something of a subjective character. Every individual has his own senses, and in general, the senses of one individual are quite different from those of another, whereas the aim of exact science is to achieve objective, universally valid knowledge. It may seem, therefore, that in adopting our present approach we have been following the wrong track.

But we must not jump to conclusions. For it will become manifest that considerable progress can be made along the line of advance now open to us. Considered as a whole, the matter reduces itself to the fact that we human beings have no direct access to the knowledge conveyed to us by exact science, but must acquire it one by one, step by step, at the cost of painstaking labors of years and centuries.

Now, if we examine the content of our sense world, it obviously falls apart into as many separate fields as we have sense organs—there is a field corresponding to sight, another to hearing, and still others corresponding to the senses of touch, smell, taste, and heat. These fields are totally different from each other, and have initially nothing in common. There is no immediate, direct bridge between the perception of colors and the perception of sounds. An affinity, such as may be assumed by many art lovers to exist between a certain shade of color and a certain musical pitch, is not directly given, but is the creation, stimulated by personal experiences, of our reflective power of imagination.

Since exact science deals with measurable magnitudes, it is concerned primarily with those sensory impressions which admit of quantitative data—in other words, the world of sight, the world of hearing, and the world of touch. These fields supply science with its raw material for study and research, and science goes to work on it with the tools of a logically, mathematically, and philosophically disciplined reasoning.

II

What, then, is the meaning of this work of science? Briefly put, it consists in the task of introducing order and regularity into the wealth of heterogeneous experiences conveyed by the various fields of the sense world. Under closer examination, this task proves to be fully consistent with the task which we are habitually performing in our lives from our earliest infancy, in order to find our way and place in our environment. This is a task which has kept man busy ever since he first began to think at all in order to be able to hold his own in the struggle for existence. Scientific reasoning does not differ from ordinary everyday thinking in kind, but merely in degree of refinement and accuracy, more or less as the performance of the microscope differs from that of the naked eye. The truth of this statement, and that it must necessarily be so, is evident from the very fact that there is only one kind of logic, and, therefore, even scientific logic cannot deduce anything else from given presuppositions than can the ordinary logic of untrained common sense.

We shall therefore obtain an intuitively clear understanding of the results which science achieves through its labors, if we take our point of departure from the experiences known and familiar to us from daily life. If we review our own personal, individual development, and consider the point which our world view has gradually reached in the course of the years, we can say that we are trying to use the facts of experience as the foundation for a unified, comprehensive and practically serviceable picture of the world in which we live; that we conceive the outside world as filled with objects which act on our various sense organs, thus producing our different sensory impressions.

However, since this practical world picture which every human being carries within himself is not a directly given notion, but an idea elaborated gradually on the basis of facts of experience, it is possessed of no final character. It is changed and adjusted by every new datum of experience, from infancy to adulthood, first at a quicker, then at a slower pace. The same principle applies to the scientific world picture. The scientific world picture or the so-called phenomenological world is also not final and constant, but is in a process of constant change and improvement. It differs from the practical world picture of daily life not in kind, but in its finer structure. It is to the world picture of daily life approximately as the world picture of the adult human being is to the world picture of the human child. Therefore the best start toward a correct understanding of the scientific world picture will be to investigate the most primitive world picture, the naive world picture of the child.

Let us, therefore, try to place ourselves as best we can, in the child's mind and world of ideas. As soon as the child begins to think, he begins to form his world picture. For this purpose, he directs his attention toward the impressions which he receives through his sense organs. He tries to classify them, and in this endeavor he makes all kinds of discoveries, such as for instance, that there is a certain orderly interrelation between the inherently different impressions conveyed by the senses of sight, touch, and hearing. If you give the child a toy, let us say, a rattle, he will find that the tactile sensation is always accompanied by a corresponding visual sensation, and as he moves the rattle back and forth, he also perceives a certain regular auditory sensation.

While in this instance the different mutually independent sense worlds appear to be interlocking to a certain degree, on other occasions the child will make an observation which he will find to be no less remarkable—that certain impressions which are completely indistinguishable from one another and have their origin in a common sense world, may nevertheless be of a totally different character. Thus, for instance, the child may look at a round electric light and observe that it looks just like the full moon. The light sensation may be exactly the same. Yet, the child finds a great difference, for he can touch the lamp, but not the moon; he can pass his hand around the lamp, but not around the moon.

What, then, does the child think as he makes these discoveries? First of all, he wonders. This feeling of wonderment is the source and inexhaustible fountainhead of his desire for knowledge. It drives the child irresistibly on to solve the mystery, and if in his attempt he encounters a causal relationship, he will not tire of repeating the same experiment ten times, a hundred times, in order to taste the thrill of discovery over and over again. Thus, by a process of incessant labor from day to day, the child eventually develops his world picture, to the degree needed by him in practical life.

The more the child matures, and the more complete his world picture becomes, the less frequently he finds reason to wonder. And when he has grown up, and his world picture has solidified and taken on a certain form, he accepts this picture as a matter of course and ceases to wonder. Is this because the adult has fully fathomed the correlations and the necessity of the structure of his world picture? Nothing could be more erroneous than this idea. No! The reason why the adult no longer wonders is not because he has solved the riddle of life, but because he has grown accustomed to the laws governing his world picture. But the problem of why these particular laws hold, and no others, remains for him just as amazing and inexplicable as for the child. He who does not comprehend this situation misconstrues its profound significance, and he who has reached the stage where he no longer wonders about anything, merely demonstrates that he has lost the art of reflective reasoning.

Rightly viewed, the real marvel is that we encounter natural laws at all which are the same for men of all races and nations. This is a fact which is by no means a matter of course. And the subsequent marvel is that for the most part these laws have a scope which could not have been anticipated in advance.

Thus, the element of the wondrous in the structure of the world picture increases with the discovery of every new law. This holds true even of scientific research and inquiry in our own day, which continually produce something new. Just think of the mysteries of the cosmic rays, or the mysterious hormones, or the remarkable revelations of the electron microscope. To the research scientist, no less than to the child, it is always a gratifying experience and an added stimulus to encounter a new wonder, and he will labor industriously to solve the riddle by repeating the same experiments with his refined instruments just as the child does with his primitive rattle.

However, let us not leap too far ahead, but proceed in an orderly fashion. First, let us investigate in what respect the structure of the child's world differs from the sense world as originally given. The first fact to claim our attention is that sensations, the sole and exclusive constituents of the original world picture, have been driven appreciably into the background. The dominant elements of this world picture are not sensations, but the objects which produce them. The toy is a dominant element, and the tactile, visual, and auditory sensations are merely secondary consequences. But we would not do full justice to the state of affairs were we to say simply that this world picture is nothing but a synthesis of different sensory impressions achieved with the help of the unifying concept of *thing*. For, conversely, a single undifferentiated sense experience may correspond to several different objects. An example of this possibility is the previously mentioned case of an illuminated surface which produces in us a definite sensory impression, and yet is sometimes attributed to an electric light and at other times to the full moon. This is a case of a single undifferentiated sensation which corresponds to two different objects. The contrast, therefore, lies deeper, and can be characterized exhaustively only by introducing the concept of an objectively valid regularity. The sensations produced by objects are private, and vary from one individual to another. But the world picture, the world of objects, is the same for all human beings, and we may say that the transition from the sense world to the world picture amounts to a replacement of a disordered subjective manifold by a constant objective order, of chance by law, and of variable appearance by stable substance.

The world of objects, in contrast to the sense world, is therefore called the "real world." Yet, one must be careful when using the word *real*. It must be taken here in a qualified sense only. For this word has the connotation of something absolutely stable, permanent, immutable, whereas the objects of the child's world picture could not rightly be claimed to be immutable. The toy is not immutable, it may break or burn. The electric lamp can be smashed to smithereens. This precludes their being called real in the sense just mentioned.

This sounds both self-evident and trivial. But we must bear in mind that in the case of the scientific world picture, where as we have seen, the situation is quite analogous, this state of affairs was by no means found to be self-evident. For just as to the child the toy is the true reality, so for decades and centuries the atoms were taken by science to constitute the true reality in natural processes. The atoms were considered to be that which remains immutable when an object is smashed or burned, thus representing permanency in the midst of all change—until one day, to everybody's astonishment, it was found that even atoms could change. Therefore, whenever in the sequel we refer to the real world, we shall be using the word *real* primarily in a qualified, naive sense, adjusted to the particular character of the dominant world picture, and we must constantly bear in mind that a change in the world picture may go hand in hand, simultaneously, with that which people call real.

Every world picture is characterized by the real elements, of which it is composed. The real world of exact science, the scientific world picture, evolved from the real world of practical life. But even this world picture is not final, but changes all the time, step by step, with every advance of inquiry.

Such a stage of development is represented by that scientific world picture which today we are accustomed to call "classical." Its real elements, and hence its characteristic feature, were the chemical atoms. In our own day, scientific research, fructified by the theory of relativity and the quantum theory, stands at the threshold of a higher stage of development, ready to mould a new world picture for itself. The real elements of this coming world picture are no longer the chemical atoms, but electrons and protons, whose mutual interactions are governed by the velocity of light and by the elementary quantum of action. From today's point of view, therefore, we must regard the realism of the classical world picture as naive. But nobody can tell whether some day in the future the same words will not be used in referring to our modern world picture, too.

III

But what is the meaning of this constant shift in what we call real? It is not utterly unsatisfactory to all men who seek definite scientific insight?

The answer to this question must be, first of all, that our immediate concern is not whether or not the situation is satisfactory, but what its essentials are. But the pursuit of this question will lead to a discovery which we must regard as the greatest of all the wonders previously mentioned. First of all, it must be noted that the continual displacement of one world picture by another is dictated by no human whim or fad, but by an irresistible force. Such a change becomes inevitable whenever scientific inquiry hits upon a new fact in nature for which the currently accepted world picture cannot account. To cite a concrete example, such a fact is the velocity of light in empty space, and another is the part played by the elementary quantum of action in the regular occurrence of all atomic processes. These two facts, and many more, could not be incorporated in the classical world picture, and consequently, the classical world picture had to yield its place to a new world picture.

This in itself is enough to make one wonder. But the circumstance which calls for ever greater wonderment, because it is not self-evidently a matter of course by any means, is that the new world picture does not wipe out the old one, but permits it to stand in its entirety, and merely adds a special condition for it. This special condition involves a certain limitation, but because of this very fact it simplifies the world picture considerably. In fact, the laws of classical mechanics continue to hold satisfactorily for all the processes in which the velocity of light may be considered to be infinitely great, and the quantum of action to be infinitely small. In this way we are able to link up in a general manner mechanics with electrodynamics, to substitute energy for mass, and moreover, to reduce the building blocks of the universe from the ninety-two different atom types of the classical world picture to two—electrons and protons. Every material body consists of electrons and protons. The combination of a proton and an electron is either a neutron or a hydrogen atom, according as the electron becomes attached to the proton or circles about it. All the physical and chemical properties a body has may be deduced from the type of its structure.

The formerly accepted world picture is thus preserved, except for the fact that now it takes on the aspect of a special section of a still larger, still more comprehensive, and at the same time still more homogeneous picture. This happens in all cases within our experience. As the multitude of the natural phenomena observed in all fields unfolds in an ever richer and more variegated profusion, the scientific world picture, which is derived from them, assumes an always clearer and more definite form. The continuing changes in the world picture do not therefore signify an erratic oscillation in a zigzag line, but a progress, an improvement, a completion. In establishing this fact I have, in my opinion, indicated the basically most important accomplishment that scientific research can claim.

But what is the direction of this progress, and what is its ultimate goal? The direction, evidently, is the constant improvement of the world picture by reducing the real elements contained in it to a higher reality of a less naive character. The goal, on the other hand, is the creation of a world picture, with real elements which no longer require an improvement, and therefore represent the ultimate reality. A demonstrable attainment of this goal will—or can—never be ours. But in order to have at least a name for it, for the time being, we call the ultimate reality the real world, in the absolute, metaphysical sense of the word *real*. This is to be construed as expressing the fact that the real world—in other words, objective nature—stands behind everything explorable. In contrast to it, the scientific world picture gained by experience—the *phenomenological world*—remains always a mere approximation, a more or less well defined model. As there is a material object behind every sensation, so there is a metaphysical reality behind everything that human experience shows to be real. Many philosophers object to the word, *behind*. They say: "Since in exact science all concepts and all measures are reducible to sensations, in the last analysis the meaning of every scientific finding also refers only to the sense world, and it is inadmissible, or at least superfluous, to postulate the existence behind this world of a metaphysical world, totally inaccessible to direct scientific inquiry and examination." The only proper reply to this argument is, simply, that in the above sentence the word behind must not be interpreted in an external or spatial sense. Instead of "behind," we could just as well say, "in" or "within." Metaphysical reality does not stand spatially *behind* what is given in experience, but lies fully *within* it. "Nature is neither core nor shell—she is everything at once." The essential point is that the world of sensation is not the only world which may conceivably exist, but that there is still another world. To be sure, this other world is not directly accessible to us, but its existence is indicated, time and again, with compelling clarity, not only by practical life, but also by the labors of science. For the great marvel of the scientific world picture, becoming progressively more complete and perfect, necessarily impels the investigator to seek its ultimate form. And since one must assume the existence of that which one seeks, the scientist's assumption of the actual existence of a real world, in the absolute sense of the word, eventually grows into a firm conviction which nothing can shake any more. This firm belief in the absolute real in nature is what constitutes for him the given, self-evident premise of his work; it fortifies repeatedly his hope of eventually groping his way still a little nearer to the essence of objective nature, and of thereby gaining further clues to her secrets.

Since the real world, in the absolute sense of the word, is independent of individual personalities, and in fact of all human intelligence, every discovery made by any individual acquires a completely universal significance. This gives the inquirer, wrestling with his problem in quiet seclusion, the assurance that every discovery will win the unhesitating recognition of all experts throughout the entire world, and in this feeling of the importance of this work lies his happiness. It compensates him fully for many a sacrifice which he must make in his daily life.

The sublime nature of such a goal must, necessarily, dwarf into insignificance any doubt engendered by the difficulties encountered while shaping the scientific world picture. It is particularly important to emphasize this in our own day, for nowadays such difficulties are sometimes regarded as serious impediments to the salutary progress of scientific work. It is an odd fact that experimental difficulties are so regarded to a lesser degree than theoretical ones. The circumstance that with the increasing demands on the accuracy of measurements the instruments, too, become more intricate, is understood and accepted as a matter of course. But the fact that, in the endeavor to improve continually the expansion of systematic interrelations, it is necessary to use definitions and concepts which diverge more and more from traditional forms and intuitive notions, is sometimes cited as a reproach against theoretical research, and is even viewed as indicating that theoretical research is entirely on the wrong track.

Nothing could be more shortsighted than such a view. For if we stop to think that the improvement of the world picture goes hand in hand with an approach to the metaphysically real world, the expectation that the definitions and concepts of the objectively real world picture will not diverge too much from the framework created by the classical world picture amounts basically to a demand that the metaphysically real world be completely intelligible in terms of ideas derived from the former naive world picture. This is a demand that can be never fulfilled. We simply cannot expect to recognize and discern the finer structure of something, so long as we flatly refuse to view it otherwise than with the naked eye. Yet, in this respect there is no reason for fear. The development of the scientific world picture is a matter of absolute necessity. The experiences gained with the refined instruments of measurement demand inexorably that certain firmly rooted intuitive notions be abandoned and replaced by new, more abstract conceptual structures, for which the appropriate intuitions are still to be found and developed. Thus, they are the landmarks to guide theoretical research on its road from the naive concept of reality to the metaphysical real.

But significant as the achievements may be, and near as the desired goal may seem, there always remains a gaping chasm, unbridgeable from the point of view of exact science, between the real world of phenomenology and the real world of metaphysics. This chasm is the source of a constant tension, which can never be balanced, and which is the inexhaustible source of the insatiable thirst for knowledge within the true research scientist. But at the same time, we catch here a glimpse of the boundaries which exact science is unable to cross. May its results be ever so deep and far-reaching, it can never succeed in taking the last step which would take it into the realm of metaphysics. The fact that although we feel inevitably compelled to postulate the existence of a real world, in the absolute sense, we can never fully comprehend its nature, constitutes the irrational element which exact science can never shake off, and the proud name "exact science" must not be permitted to cause anybody to underestimate the significance of this element of irrationality. On the other hand, the very fact that science sets its own limits on the basis of scientific knowledge itself, appears well suited to strengthen everybody's confidence in the reliability of that knowledge, knowledge obtained on the basis of incontestable presupposition and with the help of rigorous experimental and theoretical methods.

If, now, we cast our glance from the viewpoint now established back on the starting point of our considerations, and on the entire train of thoughts pursued, the results gained will become even clearer. We began our deliberations with a definite disillusionment. We sought a universal foundation on which to erect the edifice of exact science, a foundation of indisputable firmness and security—and we failed to find it. Now in the light of the insights gained, we recognize that our quest was doomed to failure even before it started. For, basically considered, our attempt was based on the idea of starting out on our scientific exploration from something irrevocably real, whereas we have now come to understand that such ultimate reality is of a metaphysical character and can never be completely known. This is the intrinsic reason that doomed to failure every previous attempt to erect the edifice of exact science on a universal foundation, valid a priori. We had to be satisfied, instead, with a starting point which was of inviolable solidity and yet of an extremely limited significance, since it was based solely on individual data of experience. It is at this modest point that scientific research enters with its exact methods, and it works its way step by step from the specific to the always more general. To this end, it must set and continually keep its sights on the objective reality which it seeks, and in this sense exact science can never dispense with reality in the metaphysical sense of the term. But the real world of metaphysics is not the starting point, but the goal of all scientific endeavor, a beacon winking and showing the way from an inaccessibly remote distance.

The assurance that every new discovery, and every new fact of knowledge gained from it, will bring us nearer to the goal, must compensate us for the numerous, and certainly not negligible, drawbacks which are necessarily created by the continual abatement of the intuitive character and ease of application of the world picture. In fact, the present scientific world picture, as against the original naive world picture, shows an odd, almost alien aspect. The immediately experienced sense impressions, the primordial sources of scientific activity, have dropped totally out of the world picture, in which sight, hearing, and touch no longer play a part. A glance into a modern scientific laboratory shows that the functions of these senses have been taken over by a collection of extremely complex, intricate, and specialized apparatus, contrived and constructed for handling problems which can be formulated only with the aid of abstract concepts, mathematical and geometric symbols, and which often are beyond the layman's power of understanding. One might feel completely at sea trying to puzzle out the meaning of exact science, and exact science has even been accused on this account of having lost its firm footing with the loss of its original intuitive character. But he who persists in this opinion, despite the reasons cited, is beyond help, and will be as unable to make any essential contribution to the progress of exact science as an experimenter who insists, as a matter of principle, on working always with primitive instruments only. For exact science demands more than a gift of intuition and willingness to work hard. It demands also very involved, painstaking, tedious attention to details, for which many scientists must often pool their efforts in order to prepare their branch of science for the next step on the ladder of gradual progress. To be sure, when the pioneer in science sends forth the groping feelers of his thoughts, he must have a vivid intuitive imagination, for new ideas are not generated by deduction, but by an artistically creative imagination. Nevertheless, the worth of a new idea is invariably determined, not by the degree of its intuitiveness—which, incidentally, is to a major extent a matter of experience and habit—but by the scope and accuracy of the individual laws to the discovery of which it eventually leads.

Of course, every step forward means also that the difficulty of the task increases, the demands on the analyst grow more exacting, and the need for an expedient division of labor becomes always more urgently imperative. In particular, the division of science into experimental and theoretical was completed about a century ago. Experimenters are the shock troops of science. They perform the decisive experiments, carry out the all-important work of measurement. An experiment is a question which science poses to nature, and a measurement is the recording of nature's answer. But before an experiment can be performed, it must be planned—the question to nature must be formulated before being posed. Before the result of a measurement can be used, it must be interpreted—nature's answer must be understood properly. These two tasks are those of the theorist, who finds himself always more and more dependent on the tools of abstract mathematics. Of course, this does not mean that the experimenter does not also engage in theoretical deliberations. The foremost classical example of a major achievement produced by such a division of labor is the creation of spectrum analysis by the joint efforts of Robert Bunsen, the experimenter, and Gustav Kirchoff, the theorist. Since then, spectrum analysis has been continually developing and bearing ever richer fruit.

Whenever an experimental finding contradicts the accepted theory, another step on the ladder of progress is thereby announced, for the contradiction signifies that the accepted theory must be overhauled and improved. But the question as to just where and how to change it entails serious difficulties. For the more tried an existing theory is, the more sensitive it is, and the stronger resistance it puts up to every attempt to alter it. In this respect, it behaves like a highly complex, widely ramified organism, whose individual component parts are mutually interdependent and are so closely interlinked that a reaction to any stimulus at any one point is also manifested automatically at quite different and, seemingly, very remote places. This gives rise to new questions, which can be investigated experimentally, and thus it may lead to consequences, the bearing and importance of which no one could suspect at the outset. This is how the theory of relativity was born, and this is the story behind the genesis of the quantum theory. In our own days, the constant growth and advancement of the youngest branch of natural science, nuclear physics, brought about and implemented by a reciprocal supplementation of experiment and theory, is another typical example of such fruitful collaboration.

IV

But why all this enormous labor, demanding the best efforts of countless soldiers of science during their entire lives? Is the ultimate result—which, as we have seen, in its individual details always drifts away from the immediately given facts of life—truly worth this costly effort?

These questions would indeed be justified if the meaning of exact science were limited to a certain gratification of man's instinctive yearning for knowledge and insight. But its significance goes considerably deeper. The roots of exact science feed in the soil of human life. But its link to it is twofold. For it not only has its source in experience, but also has a retroactive effect on human life, both material and spiritual, and the more freely it can unfold itself, the stronger and more fruitful is this effect. This manifests itself in a very peculiar manner. First, as we have found, when science works on the world picture of its own making, its quest of metaphysical reality causes it to drift always farther and farther away from the immediate facts and interests of life, since it always takes to less intuitive and more solitary trails. But these trails, and only these, are the very paths leading toward a discernment of new laws of interrelations, which would be inaccessible in any other way, and which can then be made relevant for human experience and thus made to serve human needs.

This fact can be observed in countless individual instances. Here, too, a far-reaching division of labor has proved its worth excellently. The first step, the moulding of the world picture from its beginnings in ordinary experience, is the task of pure science. The second step, the practical utilization of the scientific world picture, is the task of technology. Both these tasks are equally important, and since either of them demands a man's full energy, if an individual scientist wants to make progress in his work, he must concentrate all his energy on one single task and for the time being forget completely other problems and interests. For this reason, never reproach the scholar too harshly for his other-worldliness and his indifference to important problems of human society. Without such a one-sided attitude, Heinrich Hertz could never have discovered radio waves, or Robert Koch the tubercle bacillus. These gifts of pure scientific research to practical life have their counterparts in the manifold stimuli and intelligent assistance which science receives from technology, a fact that is becoming progressively more manifest in our day and whose importance cannot be assessed too highly.

I feel I must discuss here a little more closely, by way of an example, a very recent and very impressive case of the often quite unsuspected close interrelation of science and technology. For a great number of years, only men of pure science were interested in the distinctive facts of atomic transformations. To be sure, the magnitude of the energies thus released did attract attention, yet since atoms were so infinitesimally small, no serious thought was given to the possibility that one day they might acquire practical significance, too. Today, due to new findings in the field of artificial radioactivity, this question has taken an astonishing turn. The investigations of Otto Hahn and his collaborators have established the fact that a uranium atom bombarded by a neutron splits into several parts. Two or three neutrons are liberated, and each of them continues on its own path and may, in its turn, collide with a uranium atom and split it. Thus the effects may multiply; and it may happen that as a consequence of the increasing bombardment of uranium atoms by the liberated neutrons the energy thus released will swell like an avalanche within a very short time. To visualize this, think of the well-known example of chain letters. With the number of available atoms, this chain reaction may reach quite enormous, hardly conceivable proportions. Of course, an indispensable prerequisite for this effect is that the free neutrons, prior to their hitting uranium nuclei, are not captured by other atoms and either permanently absorbed by the latter or deflected away from uranium nuclei.

A specific computation has shown that the amount of energy released in this manner in a cubic meter (35.314 cubic feet) of powdered uranium oxide within one one-hundredth of a second is sufficient to lift a weight of one billion metric tons to a height of almost 17 miles. This amount of energy could replace the output of all the big power plants of the world combined for many years.

Up to quite recently, a technical utilization of the energy latent in the nuclei of atoms might have appeared as a utopian dream. But it was made a reality about 1942, by the impressive collaboration of British and American scientists with American industry, backed by huge government subsidies. At the present moment, several uranium piles are operating in America, and the heat continually produced by them is sufficient to raise the temperature of the Victoria River in the state of Washington by 1 degree Centigrade. So far as the reports disclose, these vast amounts of energy are still unused. Right now, the problem is to get rid of them in a harmless way. But these same piles furnish also the raw materials for the atomic bombs, in which vast amounts of the nuclear energy of the atom are liberated within a fraction of a second, producing explosions beside which the devastation caused by all chemical explosives fades into insignificance. No words can be strong enough to overemphasize the danger of self-extermination which threatens the entire human race, should a future war bring about the use of a large number of such bombs. Human imagination is incapable of conceiving the possible consequences. A particularly eloquent and forceful plea for peace is the memory of the 80,000 dead of Hiroshima and the 40,000 dead of Nagasaki, a plea addressed to all nations, and especially to their responsible leaders.

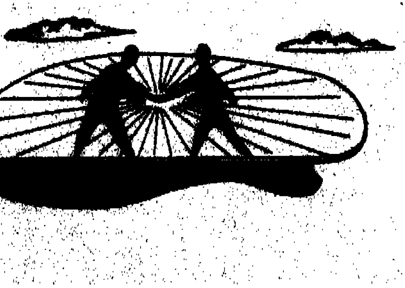
In view of these facts, perhaps many who have lost the art of wondering may feel disposed to learn it anew. And in fact, compared with immeasurably rich, ever young nature, advanced as man may be in scientific knowledge and insight, he must forever remain the wondering child and must constantly be prepared for new surprises.

Thus we see ourselves governed all through life by a higher power, whose nature we shall never be able to define from the viewpoint of exact science. Yet, no one who thinks can ignore it. A thinking human being, who has not only scientific but also metaphysical interests, must choose one of two possible attitudes: either fear and hostile resistance or reverence and trusting devotion. If we reflect on all the unspeakable suffering and incessant destruction of life and property which have plagued mankind since time immemorial, we may be tempted to agree with the pessimistic philosophers who consider life worthless and deny the possibility of permanent progress, of a betterment of mankind, and who profess instead that it is the fate of every human civilization to turn blindly against itself as soon as it reaches a certain peak, and to destroy itself without sense or purpose.

May exact science be cited as an evidence of such a far-reaching view? The answer must be "No," if for no other reason than because science is not qualified to decide the question. From the scientific point of view, one might just as well, and perhaps with even more justification, endorse the opposite opinion. It would require merely an extension of the range of observation, a thinking not in terms of centuries but of many millennia. Or is there anybody who would seriously deny that during the past one hundred thousand years *Homo sapiens* has made progress and has improved himself? Why should this progress not continue further—if not in a straight line, then at least in waves?

Of course, such considerations, such a long range view, are no help to the individual. They cannot bring him succor in his hour of need or cure his pain. The individual has no alternative but to fight bravely in the battle of life, and to bow in silent surrender to the will of a higher power which rules over him. For no man is born with a legal claim to happiness, success, and prosperity in life. We must therefore accept every favorable decision of providence, each single hour of happiness, as an unearned gift, one that imposes an obligation. The only thing that we may claim for our own with absolute assurance, the greatest good that no power in the world can take from us, and one that can give us more permanent happiness than anything else, is integrity of soul, which manifests itself in a conscientious performance of one's duty. And he whom good fortune has permitted to cooperate in the erection of the edifice of exact science will find his satisfaction and inner happiness, with our great German poet, in the knowledge that he has explored the explorable and quietly venerates the inexplorable.

This chapter is taken from the forthcoming book Scientific autobiography and other papers *by the late Max Planck, to be published by the Philosophical Library on October 17.*



TECHNICAL PAPERS

Preparation of Radioautographs of Tissues without Loss of Water-Soluble P^{32}

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A study of techniques for use in preparation of radioautographs with animal tissues which contain radioactive elements in water-soluble form has been made. Conventional histological methods of fixation, cutting, and mounting the tissue result in the loss of a large fraction of the radioactive element before the tissue section is ready for exposure to the photographic emulsion. A recent investigation (*2*) presents evidence which indicates that essentially all of the P^{32} remaining in animal tissues that have been handled by the usual methods is that which has been incorporated in the tissue as newly formed nucleic acids. However, 2 hr after the administration of labeled phosphate to a mature rat the amount of the phosphate that is present as desoxyribosenucleic acid represents only 0.14% in the liver and 4.81% in the intestinal mucosa of the total inorganic phosphorus incorporated in these organs (*1*). The present investigation describes procedures which make it possible to use the radioautographic technique for a more complete study of the distribution of P^{32} in tissues. The objective of the study has been to devise simple methods to prepare the tissue section and mount it on the photographic emulsion without encountering any appreciable loss, or shift in distribution, of the radioactive element.

A recent report by Russel, Sanders, and Bishop (*3*) describes the use of a freezing substitution technique to study the distribution of P^{32} in plant tissues. In this technique the tissue is frozen at – 170° C and then transferred to absolute alcohol saturated with basic lead acetate to precipitate the phosphate *in situ* as lead salt during dehydration. While this technique is reported by these investigators to give good results for plant tissues, a somewhat similar technique employed by us with animal tissues has failed to give entirely satisfactory results. Rat tissues were fixed in alcohol-formalin which was saturated with basic lead acetate; this was followed by dehydration with the usual alcohol series, each alcohol solution being saturated with basic lead acetate. Measurements of these solutions for radioactivity showed that very little was lost from the tissue; however, stained sections and radioautographs indicated that the phosphate was being precipitated around the periphery of the tissue, which also hardened and became difficult to cut. Freezing before treatment with a lead salt was not tried.

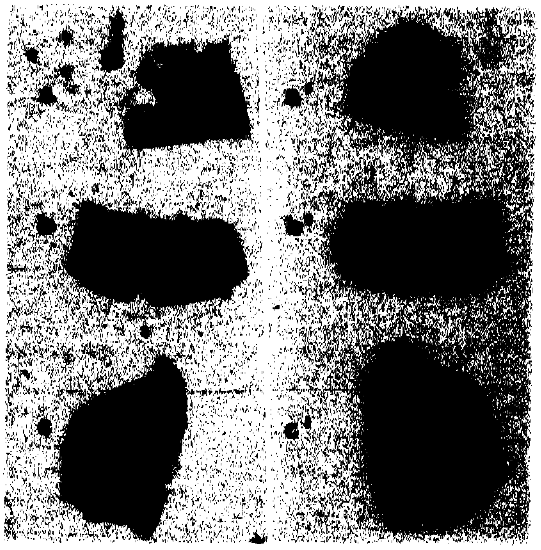

FIG. 1. Stained sections (a, b, c) and corresponding radioautographs (a′, b′, c′) of these sections from three adjacent pieces of the liver of a rat injected with P^{32}; the three sections were fixed and dehydrated by methods A, B, and C respectively as described in the text. (Enlarged approximately 4 ×.)

A freezing and vacuum dehydration technique (method A) for preparing tissues containing P^{32} was tried and the resulting radioautographs have been compared with those obtained from tissues prepared by two other methods.[3] Fig. 1 shows radioautographs and stained sections made from adjacent pieces of the liver of a 96-g rat which had been injected subcutaneously with 0.75 mc of carrier-free P^{32} 2 hr before sacrifice. The section shown in Fig. 1a was prepared by method A, which consists of immersion of the tissue in isopentane cooled to – 170° C, followed by vacuum dehydration. Following freezing the tissue was kept at – 70° C under a pressure of 0.1 mm Hg for a period of about 48 hr; the tissue was then allowed to come slowly to room temperature in the vacuum. Infiltration of the tissue was accomplished by placing it in liquid paraffin at 40° C under a pressure of 20 mm Hg for 2 hr. The histological results obtained with this procedure were good and were reproducible. The section shown in Fig. 1b was prepared by method B with the following series: alcohol-formalin (9: 1), 2 hr; 95% alcohol, 1 hr; absolute alcohol, 1 hr; absolute alcohol-xylol (1: 1), 1 hr; cedarwood oil, 1 hr; cedarwood oil, over-

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[1] Atomic Energy Commission Postdoctoral Research Fellow in the Biological Sciences.

[2] This work was done under contract from the Office of Naval Research and the Atomic Energy Commission. The authors wish to express their appreciation to Mrs. Kathryn Haley for her assistance.

[3] Radioactive phosphorus supplied by the Oak Ridge National Laboratory and obtained on allocation from the U. S. Atomic Energy Commission.

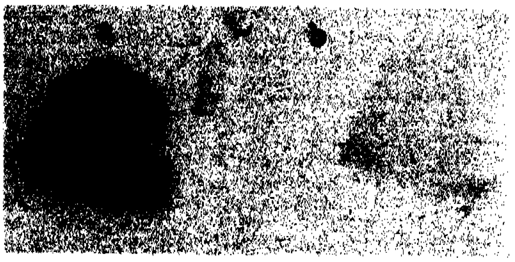

FIG. 2. Radioautographs of two successive sections of rat liver cut from the same block and exposed simultaneously; a differs from b in having no contact with water during the procedure of mounting the tissue on the slide. (Enlarged approximately 4 ×.)

night; clearing in xylol and embedding in paraffin. The series (method C) used for the section shown in Fig. 1c was as follows: alcohol-formalin (9:1), 2 hr; three changes of dioxane (2 hr, 1 hr, 1 hr); followed by the usual paraffin infiltration and embedding. The method of cutting and mounting sections from paraffin blocks was the same with all three sections shown in Fig. 1 and will be described. All three sections were mounted on the same slide and the slide was used for making the radioautographs, which are also shown in Fig. 1 (a′, b′, and c′). The exposure was made by clamping the slide against the emulsion of an Eastman Kodak NTB3 Nuclear Track Plate. The exposure time was 48 hr and was started 14 days after the injection of the animal. This newly developed emulsion is very satisfactory for obtaining radioautographs with P^{32} because of its high sensitivity to high energy beta particles. It can be seen that the amount of P^{32} retained by the tissue, as judged by the radioautographs, is not markedly different in the three methods of fixation and dehydration. However, measurements were made of radioactivity present in the solutions used in preparing tissues by method B and it was found that roughly 25% of the activity present in the tissue was lost to the solutions. This loss was less for method C (i.e., dioxane is preferable to the use of alcohols for dehydration), and in method A (the freezing and vacuum dehydration technique) no loss was possible. These three methods were chosen specifically to minimize the loss of P^{32}. While no data are available, the use of other methods (in particular the use of acid fixatives or prolonged periods of contact with solutions) would probably result in greater loss.

The method of cutting and mounting the sections was found to be very important. It is again desirable to avoid, if possible, contact with all solutions which will extract the P^{32}. This has been accomplished as follows: The sections are cut at the usual thickness of about 8 μ. Before cutting each section, the surface of the block is coated with a thin layer of melted paraffin. After this has cooled for a few seconds the section is cut; allowing the proper cooling time will avoid compression of the paraffin or curling, which occurs if the time is either too short or too long. This layer of paraffin serves as a backing for the section and has avoided the difficulties with curling and folding of the section which occur with a 8-μ section which has no backing and has not been floated on water for flattening. The section may then be mounted directly on a slide and the paraffin removed with xylol or not, as desired. The sections shown in Fig. 1 and in Fig. 2 were cut and mounted in this way on slides coated with a small amount of egg albumen; the slides were placed in the oven (40° C) for a few minutes before removal of the paraffin with xylol. In order to avoid the possibility of chemical action of the tissue on the emulsion, a thin piece of cellophane was placed between the tissue and the emulsion before they were clamped together. Fig. 2 shows radioautographs obtained from two successive sections cut from the same block of frozen, dehydrated liver and exposed simultaneously to the same plate (this was also a 48-hr exposure to an NTB3 emulsion). The two sections were different only in the following respect: after cutting, section 2b was placed on a dish of water with the tissue in contact with the water surface for a period of time judged to be similar to that used in the regular procedure when the ribbon is floated on water before mounting. The marked difference in the density of the radioautographs in Fig. 2a and 2b demonstrates the loss of a large fraction of the P^{32} by floating the section on water.

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On the Relationship of Blood Group A to Rh Immunization and the Occurrence of Hemolytic Disease of the Newborn

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In the course of an analysis of immunological data collected from 11,649 pregnant women during the years 1943–1948 inclusive, there was observed a larger number than expected of individuals of blood group A among the sensitized Rh-negative women who bore infants afflicted with hemolytic disease of the newborn. The question was then raised as to whether a relationship could be established between the presence of group A in the red blood corpuscles and an increased incidence of response to immunization on the part of an Rh-negative woman bearing an Rh-positive fetus; and secondly, whether the presence or absence of hemolytic disease of the newborn could in part be related to the ABO blood group of the Rh-positive infant.

The ABO blood group frequencies of the sensitized Rh-negative women and their offspring were compared with the distribution of ABO blood groups in a random sample of the population of this area. In order to determine whether the four ABO blood group frequencies in the category of sensitized Rh-negative women showed statistically significant variations from the normal blood group frequencies, the data were submitted to the chi-square test and the resultant values are listed with the probabilities of their occurrence by chance alone (Table 1). The magnitude of increase of blood group A subjects among sensitized Rh-negative women who bore afflicted infants is one which might be expected to occur by chance alone only twice or thrice in 100 similar samples. It is therefore reasonable to assume that factors other than chance may be responsible for the production of this deviation. The variations in blood group frequencies among sensitized Rh-negative women bearing normal infants (Rh positive or Rh negative) showed no significant variation from the normally occurring distribution of blood groups. These data demonstrate that proportionately more women of blood group A showed Rh sensitization and were delivered of infants suffering from hemolytic disease of the newborn than women of the blood groups O, B, or AB.

TABLE 1

ABO BLOOD GROUP FREQUENCIES IN SENSITIZED RH-NEGATIVE WOMEN AND THEIR OFFSPRING ARRAYED ACCORDING TO THE CLINICAL CONDITION OF THE CHILD

Categories		Rh positive, hemolytic disease of newborn		Rh positive, normal child		Rh negative, normal child		Totals and average %		ABO blood group in random sample of population
	$n =$	124		78		26		228		5175
		n	%	n	%	n	%	n	%	
Sensitized Rh-negative women	O	43	34.7	36	46.2	11	42.3	90	39.5	44.8%
	A	66	*53.2*	32	41.1	10	38.5	108	47.4	39.7%
	B	11	8.9	7	8.9	4	15.4	22	9.6	11.3%
	AB	4	3.2	3	3.8	1	3.8	8	3.5	4.2%
	$\chi^2 =$	*9.53*		0.46		0.47		5.64		
	$p =$	*0.03–0.02*		0.95–0.90		0.95–0.90		0.20–0.10		
	$n =$*	97		77		26		200		
		n	%	n	%	n	%	n	%	
Children of sensitized Rh-negative women	O	50	51.5	41	53.2	6	23.1	97	48.5	
	A	39	40.3	23	29.9	14	53.8	76	38.0	
	B	7	7.2	12	15.6	4	15.4	23	11.5	
	AB	1	1.0	1	1.3	2	7.7	4	2.0	
	$\chi^2 =$	4.72		5.87		5.19		3.07		
	$p =$	0.20–0.10		0.20–0.10		0.20–0.10		0.50–0.30		

* The differences in numbers of sensitized Rh-negative women and children born to them are due to lack of information concerning the ABO groups of 28 infants.

Chown (*2*) analyzed the blood groups of 46 mothers of erythroblastotic children and found among them "a significantly greater number of Group AB women and a significantly smaller number of Group B." The frequency of group A in his series was normal. Cappell (*1*) found a significantly higher frequency of group A individuals among sensitized Rh-negative women. Our data differ from those of Cappell in that the significant preponderance of group A subjects occurs among those Rh-negative women who showed laboratory evidence of Rh sensitization and gave birth to infants afflicted with hemolytic disease of the newborn.

When the ABO blood group frequencies in the three categories of infants were compared with the normal frequencies, no statistically significant differences were observed. However, in the sample of Rh-positive normal infants there is a suggestive decrease in group A (29.9%) and an increased incidence of blood group O (53.2%) individuals among them, although the increase is not statistically significant. In the small sample (26) of Rh-negative normal infants, a decrease in group O (23.1%) and an increase in group A (53.8%) occurs. It may be that the sensitized Rh-negative women, who bore the latter group of infants, originally formed Rh antibodies in response to a previous exposure to Rh-positive blood and therefore are to be considered as examples of the "carry-over" or anamnestic phenomena. The data indicate that an Rh-negative blood group A or B fetus *in utero* may stimulate an anamnestic rise of Rh antibodies in an already sensitized woman more readily than a fetus of group O; but this requires further confirmation.

In summary, in a sample of 228 sensitized Rh-negative women, 124 bore children afflicted with hemolytic disease of the newborn. Of these 124 women 66 (or 53.2%) belonged to blood group A. The chi-square test on these data demonstrate that they are of probable statistical significance ($p = 0.03–0.02$) and the inference may be made that this unusual increase in the incidence of blood group A mothers is not due to chance alone. These data indicate a possible relationship between blood group A of the mother and the character of her immune response to the Rh factor as antigen. The infants afflicted with hemolytic disease of the newborn showed a normal distribution of ABO blood groups.

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Strontianite and Witherite Associated with Southern Illinois Fluorite

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Strontianite and witherite have been identified in specimens of fluorspar from the Minerva Oil Company Mine No. 1, NW¼ SE¼ sec. 24, T. 11 S., R. 9 E., about 5 miles north of Cave-in-Rock, Hardin County, Illinois. The original specimens were collected on October 25, 1948, by Charles E. Tothill, on a senior student trip through the mine. These specimens consisted of barrel-shaped mosaic aggregates which had been identified as barite. The student, impressed by the unusual habit of the "barite," brought the specimens to the senior author, who recognized the crystals as witherite twins. Upon request, the superintendent of the mine, Mr. Gill Montgomery, furnished additional specimens of the same material. At the suggestion of the senior author, the junior author visited the mine during the Christmas vacation to study the occurrence of the minerals. The complete results of his study will be published later.

The fluorite in the Minerva Oil Company Mine No. 1 replaces the Downey's Bluff (Renault) limestone of Upper Mississippian, Chester age. The deposit is capped by the Bethel sandstone of the same age. Similar replacements in other Chester and Ste. Genevieve limestones are found at Cave-in-Rock at Crystal, Davis No. 2, Lead Hill, Victory, and other mines east of the Peters Creek fault zone in southern Illinois. In answer to a query concerning the occurrence of witherite in the Cave-in-Rock district, E. A. Brecke stated that early in 1943 he had noted the pseudohexagonal twins in the West Green Mine of the Ozark-Mahoning Company and had identified them as witherite. In this mine, according to Brecke, the fluorite replaces the Fredonia limestone and the deposit is capped by the overlying Rosiclare sandstone.

The principal commercial mineral in the Cave-in-Rock district is fluorite, but it is accompanied by barite, calcite, chalcopyrite, galena, greenockite, quartz, sphalerite, strontianite, and witherite. Although galena is recovered at the Ozark-Mahoning mill, only the cadmium-bearing sphalerite and the fluorite are recovered at the Minerva Oil Company Mine No. 1. According to Mr. Montgomery, a sudden increase in the barium content of the fluorspar concentrate was noted as soon as fluorspar from a new stope began to be milled. In this stope the so-called "hexagonal barite crystals" were found. The flotation reagents that previously had been successful in depressing the barite were not effective on this unusual form of "barite," which floated and was concentrated with the fluorite. After the barium mineral was correctly identified as witherite, the high barium content of the fluorspar concentrate from the new stope was explained. Examination of the mine showed that witherite is present in minor amount throughout the mine, but in the new stope it ocurs in larger crystal aggregates and it is more abundant than elsewhere. Since the discovery of the witherite, adjustment of the mill feed has made possible the maintenance of a flotation product that is acceptable to the glass industry.

The witherite occurs in pseudohexagonal twinned mosaic crystals with dense, creamy-white, waxy-lustered cores which are surrounded by nearly colorless, twinned, glassy crystals. The twins have a maximum length of 3 in. and a width of 1½ in. The dominant forms are the unit prism and several dipyramids. The crystals appear to be terminated by basal pinacoid faces but closer examination reveals that the terminal faces belong to a poorly developed, nearly flat dipyramid. The pseudohexagonal form of the twins is usual for witherite twinned on the unit prism, but the twins from the Minerva mine are unusual in exhibiting not only the usual cyclic twinning but also polysynthetic twinning, as well as mosaic structure. These features are revealed in thin sections examined in polarized light. The twins are not as simple as they appear. Under an ultraviolet lamp the witherite exhibits a strong whitish fluorescence and a weak phosphorescence. Identification of the mineral was verified by qualitative chemical tests, accurate density determinations, and by an X-ray diffraction pattern. Vugs in the deposit are lined with witherite, which appears to be an alteration product of barite, although not always is it directly associated with barite. The barite does show the effects of solution and much of it occurs in dull white pulverulent masses. In the Ozarks-Mahoning Mine the witherite is corroded. Here it is closer to the surface than at the Minerva Oil Company's mine and it has been partially dissolved by circulating ground water.

The strontianite occurs in slightly pinkish bladed grains and in brown fibrous aggregates. The brown coloration is due to a slight amount of oil associated with the mineral. Both forms of strontianite are distinctly radial. Crystals of this mineral have not been observed. Identification was based on chemical tests and upon X-ray diffraction patterns. Strontium has not hitherto been reported as occurring in this deposit. Strontianite was deposited prior to the barium-bearing minerals and after the sphalerite and the bulk of the fluorite.

A preliminary study indicates that the order of crystallization of the minerals at the Minerva Oil Company Mine No. 1 is: fluorite, sphalerite, calcite, barite, strontianite, witherite, fluoride, quartz, and calcite, with chalcopyrite being deposited contemporaneously with witherite and with both the early and the late fluorite. Although a little galena does occur at this property its exact mineral relationships could not be determined from the specimens collected by the writers. Additional studies are being made to work out the paragenesis in greater detail. The search for witherite and strontianite has been extended to other mines in the Cave-in-Rock district and to the vein deposits at Rosiclare, but to date additional occurrences have not been found.

Grignard Coupling at High Temperatures

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The reaction $2RX + Mg \rightarrow MgX_2 + R\text{-}R$, in ether solution, occurs readily when *R* is an allylic group (*1*), to a small extent when *R* is alkyl (*1*), and apparently not at all when *R* is vinyl or a substituted vinyl group (*2*).

A method has been used which increases the yield of such reactions. The pure halide vapor is passed through a tube of magnesium turnings at temperatures over 250° C, in a helium atmosphere. Yields of 10% of octane are obtainable from one pass of *n*-butyl bromide at 330° C, at a rate of 3 ml/min through a tube of magnesium 18 mm in diam and 80 cm long. Unused halide may be recovered by distillation. The magnesium bromide (or chloride) forms a porous film on the magnesium and does not prevent it from reacting until it is substantially consumed.

When a vinyl halide (1-chloro-2-methyl-1-propene) was passed over magnesium in helium at 340° C, and the product distilled, a drift in physical properties at the end of the distillation indicated the presence of small amounts of octenes, but no identified product other than the starting material was isolated.

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The Preparation of Formaldehyde-C^{14}[1]

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No satisfactory preparative method for formaldehyde-C^{14} has been reported. The production of this important intermediate has now been accomplished by an adaptation of the formaldehyde synthesis of Henry (*1*) and of Michael (*2*). Vacuum line technique was used.

Methyl-C^{14} acetate was prepared by reaction of methanol-C^{14} (*3*) with acetyl chloride. The monochlorination of methyl acetate to produce chloromethyl acetate, indicated by Henry to be favored by moderate temperatures, was performed in the present case by allowing a frozen equimolar mixture of chlorine and methyl-C^{14} acetate to warm to room temperature. The product, chloromethyl-C^{14} acetate, a methylenating agent (*5*), was readily hydrolyzed with excess water to produce a formalin solution of any desired concentration containing acetic and hydrochloric acids. Vacuum distillation of this solution gave para-formaldehyde as a residue and a more dilute formaldehyde solution as the distillate.

The yield of formaldehyde solution from methanol was consistently about 60%, analyzed by precipitation of the dimedone derivative. The specific activity of formaldehyde-C^{14}-dimedone prepared by this procedure from methanol-C^{14} (12.00 μc/millimole) was 12.18 μc/millimole as determined by dry combustion and ion-current measurement by means of a vibrating reed electrometer (*4*).

Thirty millicuries of neutral formaldehyde solution of specific gravity 250 μc/millimole have been prepared by dilution of the hydrolysis solution with carrier formalin, neutralization, and distillation at atmospheric pressure.

Studies are in progress involving the chlorination of the methyl esters of other acids and use of formaldehyde-C^{14} and chloromethyl-C^{14} acetate as synthetic intermediates.

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Determination of the Fate of Calcium in the Laying Hen by Means of Radiocalcium (Ca^{45})[1]

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Calcium metabolism in the laying hen can be studied with the aid of Ca^{45}. A direct approach to this problem is to replace the limestone powder in the mash by $CaCO_3$ containing Ca^{45} (*1*). In a typical experiment a hen ("A") was fed 1.71 g $CaCO_3$ with a Ca^{45} activity of approximately 2×10^6 cpm. The calcium in the eggs and droppings was separated in the usual way as CaC_2O_4 and its activity determined by means of a thin window Geiger counter. Corrections for decay and self-absorption were made. Total calcium was determined. The percentages of Ca^{45}, which are also the percentages of active $CaCO_3$, appearing in different parts of successive eggs are shown in Fig. 1.

The close similarity of this curve with that reported by Comar and Driggers (*2*), who administered 1 mg of radioactive calcium as a solution of the chloride to the lower esophagus of a fasted bird, is worthy of note. The recovery of calcium was at a maximum (29%) in the shell of the second egg and decreased very rapidly in the shells of later eggs. This is in agreement with the well-known fact that the shell is laid down in about 20 hr of oviposition. Fig. 2 shows the percent uptake of Ca^{45} in the shell, white, and yolk. The histogram for the yolk is

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[1] This document is based on work performed under Contract Number W-7405 eng 26 for the Atomic Energy Project at Oak Ridge National Laboratory.

[1] Paper given at a meeting of the Chemical Institute of Canada at Saskatoon on October 9, 1948.

[2] We are indebted to the National Research Council of Canada for financial assistance.

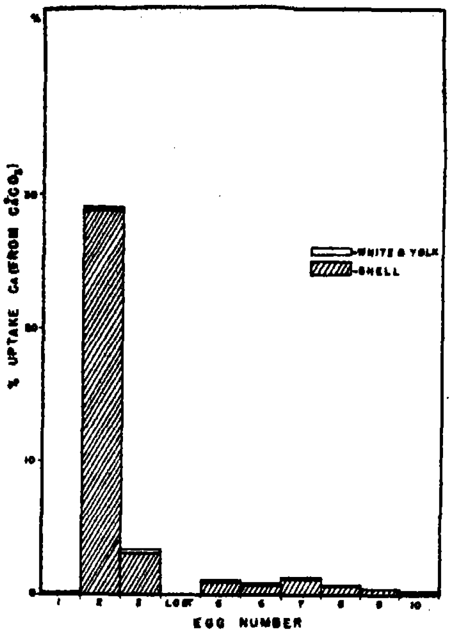

FIG. 1. Percentage of Ca^{45}, fed as a single dose of radioactive CaCO$_3$, appearing in successive eggs.

of interest, since it is in marked contrast to those for the white and the shell but is in good agreement with that previously reported for phosphorus uptake (*3*). A large portion (50%) of the calcium was excreted within 48 hr.

Another bird ("B") was then given a daily feed containing 1.7 g of active CaCO$_3$ for 10 consecutive days (multiple feeding trial). The results of this trial (Fig. 3) indicate that the percentage uptake of calcium from a given source (in this case active CaCO$_3$) became relatively constant in about 8 days after the first feeding.

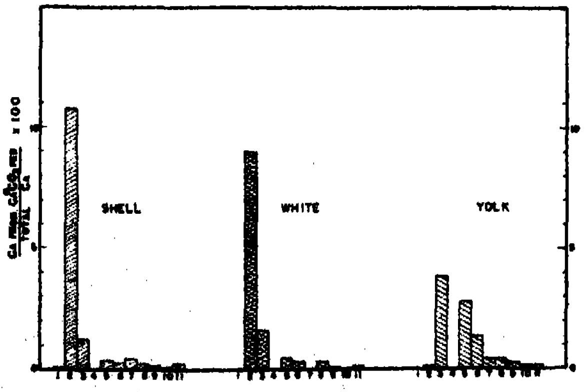

FIG. 2. Percentage of calcium that came from the active CaCO$_3$, appearing in shell, white, and yolk of successive eggs.

This is in striking contrast to the 15 days for P^{32} (*3*) but is still in excellent agreement with theory. Since the calcium fed in a given day appears in a number of eggs, it follows that the calcium in any given egg comes from the calcium fed on many different days. Thus, the recovery of calcium (expressed as a percentage of the daily calcium fed) in successive eggs in a multiple feeding experiment is a summation of the recoveries in successive single feeding experiments (see Fig. 3, hen "A").

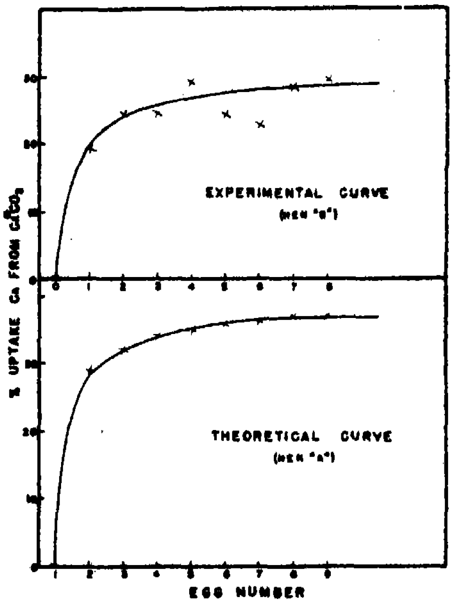

FIG. 3. Percentage of daily feed of calcium appearing in successive eggs in multiple feeding trial; theoretical curve (hen "A"), experimental curve (hen "B").

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Serologic Relationships of Mumps and Newcastle Disease

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The presence of neutralizing and antihemagglutinating factors against Newcastle disease virus (NDV) in half of patients convalescing from mumps suggests a possible relationship between the two viral agents. These cross-reacting factors were first observed in the course of an outbreak of mild meningo-encephalitis, suggestive of Newcastle disease because the epidemiologic and clinical findings fitted descriptions by Howitt *et al.* (*4*) of a disease in man which led to the formation of NDV neutralizing antibodies. Paired sera from cases of mild meningo-encephalitis showed little or no rise of neutralizing capacity against NDV, but a few pairs of mumps sera included as controls exhibited a sharp rise against this virus. Accordingly mumps sera were further investigated. Neutralization tests and calculation of neutralization indices were made by methods similar to those described by Howitt *et al.* (*4*), with few modifications. The California strain

No. 11,914 of NDV was employed throughout. Twenty-two mumps patients were studied, along with 23 control patients, 17 from the outbreak of mild meningo-encephalitis, and 6 having a clinical diagnosis of nonparalytic poliomyelitis. Thirteen of the mumps patients developed neutralization indices over 250, ten having indices of 1,000 and above, whereas only three of the sera from control patients showed neutralization indices over 250 and none went over 800. Antihemagglutination tests with mumps sera against NDV likewise demonstrated serologic relationships. Seven of 20 pairs of heat-inactivated mumps sera showed 4-to-64-fold rise of titer between the acute and convalescent phases. Four others showed titers of 1:64–1:256 in convalescent phase sera, titers well above those encountered in 20 pairs of sera from the control group of patients, none of which showed a rise of antihemagglutinating capacity against NDV.

The diagnosis of mumps in the patients studied has been considered elsewhere (*6, 9*). In addition to confirmatory epidemiologic and clinical findings, all of the patients showed evidence of recent mumps infection by complement fixation or by antihemagglutination tests, using the Enders strain of mumps virus. Mumps virus was isolated from the saliva or spinal fluid of 11 patients.

The positive results obtained in two types of serological tests against NDV in the sera of patients experiencing infection with mumps virus suggests that a diagnosis of Newcastle disease in humans should be made with caution, especially in the absence of virus isolation. Only five cases of human infection with NDV (*1, 2, 5*), all having mild conjunctivitis, have been known to be so confirmed. The presence of neutralizing and antihemagglutinating factors against NDV in convalescent phase mumps sera is difficult to interpret. The reactions may be due to nonspecific serum factors arising as result of infection rather than to specific antibodies. If the factors are actually antibodies, their presence would support the hypothesis that NDV and mumps virus are closely related. Burnet (*3*) first presented evidence for this in his work on receptor gradients. Kilham (*7*) has recently shown that NDV has a hemolytic activity closely resembling that demonstrated by Morgan, Enders, and Wagley (*8*) for the mumps virus. A more complete presentation of the data in this paper is in course of preparation. Further studies are needed to elucidate the full meaning of serologic and other relationships which appear to exist between NDV and mumps virus.

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Comments and Communications

Method for Isolation of *Actinomyces israeli* from Dento-Bacterial Plaque[1]

The dento-bacterial plaque is a minute mass of salivary debris and bacterial cells firmly attached to inaccessible tooth surfaces. The association of the plaque with the initial lesion of dental caries has been firmly established (Dietz, F. H. *J. D. Res.*, 1943, **22**, 423; Stephan, R. M. *J.A.D.A.*, 1940, **27**, 218). A microsectional study (Ennever, J., Robinson, H. B. G., and Kitchin, P. C. *J. D. Res.*, 1948, **27**, 599) of the bacterial plaque has shown that bizarre, elongated, apparently branched, Gram-positive rods make up a large portion of the plaque stroma. As a result of this morphologic suggestion, a study was undertaken to determine whether *Actinomyces israeli* is a consistent component of the plaque flora.

After repeated trials it became apparent that uniform recovery of *A. israeli* from plaque material was not possible by the method of Rosebury, Epps, and Clark (*J. Int. Dis.*, 1944, **34**, 131), even though their method affords an excellent means of cultivating the organisms from gingival scrapings, actinomycotic pus and other contaminated sources. It was felt that the sporadic isolations of *A. israeli* from the plaque centered about the physical difficulty of inoculating the culture medium. The following modifications of the Rosebury, Epps, and Clark method were instituted and have given consistently successful isolation of *A. israeli* from the dento-bacterial plaque.

The plaque mass, grown in the mouth on a tooth-bearing removable appliance, was removed with a sterile, hooked blade and placed in a micromortar containing 0.05 ml of autoclaved saline with Triton A-20 at 1:200. A coarse suspension was prepared by trituration with a small, sterile glass pestle for several minutes. One visible granule was transferred by means of a capillary pipette to brain-heart infusion agar, streaked, and the preparation incubated anaerobically in an atmosphere of 5% CO_2 for six days.

Fifteen attempts to isolate *A. israeli* from this source have been uniformly successful. Care, however, must be exercised in seeding the visible granule. It is imperative that only a small quantity of the saline diluent accompany the granule. If too much liquid is introduced on the culture medium, the easily emulsified portions of the plaque flora, present in the liquid, outgrow and obscure the *A. israeli*.

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[1] This study from the Ohio State University, College of Dentistry, and Research Foundation, Columbus, Ohio, was supported by a grant from the Proctor and Gamble Company, Cincinnati, Ohio.

Studies of the occurrence of *Actinomyces israeli* in a large series of dento-bacterial plaques are in progress.

J. Ennever, Hamilton B. G. Robinson,
and Paul C. Kitchin

The Ohio State University

Statement on Visa Action

Seventy-nine scientists attending the Fourteenth Cold Spring Harbor Symposium on Quantitative Biology in June signed the following statement:

"We, the undersigned scientists, in attendance at a Symposium on Amino Acids and Proteins at the Biological Laboratory, Cold Spring Harbor, June 8 to 16, 1949, desire to protest the action of the United States authorities in refusing a visa to our British colleague, Dr. R. L. M. Synge. A presumptive political affiliation has been given as a reason for the refusal to allow Dr. Synge to attend this scientific conference, which has no political implications. This regrettable action has deprived the symposium of the scientific judgment of an exceedingly able worker, and thus has done disservice to the progress of science in this country. Furthermore, we sincerely believe that it is in the national interest to permit scientists such as Dr. Synge to visit the United States.

Resolved, That this statement be sent to the President of the United States, and copies to the Secretary of State, the Attorney General, the Chairmen of the House and Senate Committees on Foreign Relations, the President of the National Academy of Sciences, the National Research Council, and *Science*."

Scientists attending the symposium were shocked by the refusal of the Department of State to grant a visa to Dr. Synge, since he is not a communist, but a man of liberal views and not active in politics. They were also disturbed by the discourteous treatment shown this prominent British colleague by American officials. Dr. Synge applied for a visa in March, at the American consulate in Edinburgh; and even though he was assured that a prompt answer to his application would be forthcoming, he never received an official notification of the decision to refuse it. After repeated requests for a decision, the director of the Biological Laboratory was informed by the Visa Division of the Department of State of the refusal to grant a visa only seven days before the beginning of the symposium.

M. Demerec

Long Island Biological Association

NEWS and Notes

Max S. Dunn, professor of chemistry at the University of California at Los Angeles, has been named faculty research lecturer for 1949–50. Dr. Dunn was selected in recognition of his contribution to the development and application of microbiological methods for the quantitative estimation of amino acids.

L. G. M. Baas Becking, deputy chairman of the South Pacific Commission Research Council, has been named chairman of the Committee on Botanical Stations of the International Union of Biological Sciences.

Gordon Ferrie Hull, Jr., professor of physics at Dartmouth College, has received a leave of absence to study European developments in physics for the Office of Naval Research. Dr. Hull will also deliver lectures on research which he has been conducting at Dartmouth. He will have his headquarters at the U. S. Embassy in London.

Louis N. Katz, director of cardiovascular research at the Michael Reese Hospital, Chicago, will deliver the 12th Annual Louis Gross Memorial Lecture, October 26 at the Jewish General Hospital in Montreal, Canada. Dr. Katz' subject will be "Clinical Electrocardiography — Its Present Position and Possible Potentialities."

David G. Mandelbaum, professor of anthropology at the University of California, has begun a series of studies of the Kotas, inhabitants of the Nilgiri hills of South India. Dr. Mandelbaum will visit Delhi, Bombay, Madras, and Calcutta. His work will be made possible by a Guggenheim fellowship and grants from the Social Science Research Council and the university's Rockefeller Committee on Far Eastern Studies.

Gordon R. Willey, acting director of the Institute of Social Anthropology of the Smithsonian Institution, has been appointed Bowditch Professor of Central American and Mexican Archaeology and Ethnology of the Peabody Museum, Harvard University, effective July 1, 1950. Professor Willey is the first holder of the Bowditch professorship.

Richard W. Cook, who has been acting manager of the Atomic Energy Commission's operations at Oak Ridge, has been appointed manager. Mr. Cook succeeds **J. C. Franklin,** who resigned in June.

John L. Brooks, assistant professor of zoology at Yale University, has just returned from Burma. While serving as visiting professor of zoology at Rangoon University during the academic year 1948–49, Dr. Brooks organized a research program in freshwater biology.

Lynn S. Beedle, research engineer for the Department of Civil Engineering at Lehigh University, will spend three months at Cambridge University coordinating liaison on studies being made at the two universities on the strength of welded steel frames and their components. The trip is sponsored by the Welding Research Council and the Office of Naval Research, in cooperation with the American Institute of Steel Construction, the American Iron and Steel Institute, and the Lehigh University Institute of Research.

Visitors to U. S.

Sir John L. Simonsen, British chemist, and director of Great Britain's Colonial Products Research Council, arrived in New York City September 16. Sir John addressed the American Chemical Society's Division of Organic Chemistry at the Atlantic City meeting and received the new $1,000 Fritzsche award for his research in essential oils.

Etienne Wolff, professor of zoology and experimental embryology at the University of Strasbourg, France, is spending several months visiting the laboratories of experimental embryology at a number of colleges and universities, including Yale, Connecticut, Chicago, Amherst, Johns Hopkins, and Washington University at St. Louis.

Visitors at the National Bureau of Standards during the week of September 12 included **Olli Ant-Wuorinen,** director, Chemical Laboratory, State Institute for Technical Research, Helsingfors; **S. S. Bhatnager,** director, Indian Scientific Research Office, New Delhi; **W. P. Fletcher,** British Rubber Producers' Association, England; **L. C. Jackson,** Department of Physics, University of Bristol, England; **Halvor Nordbo,** of the Agricultural College of Norway; **Hugh C. Simpson** and **Hugh Thompson,** both of the Imperial Chemical Industries Ltd., England.

Grants and Awards

The Oak Ridge Institute of Nuclear Studies has granted research awards to Alfred Brauer, professor of mathematics at the University of North Carolina, Walter Gordy, associate professor of physics at Duke University, and Allen T. Gwathmey, associate professor of chemistry at the University of Virginia. The awards were presented for "significant contributions to science in the South."

The Society for Pediatric Research has announced that during the academic year 1948–49, seven Mead Johnson Fellows were appointed and have completed a year's postgraduate work. The seven fellows and the institutions at which they have worked are: *Fabio do Amaral,* Brazil, Children's Orthopedic Hospital, Seattle, Washington; *Hsu Hankuang,* China, Children's Hospital, University of Cincinnati, and the Phipps Institute, University of Pennsylvania; *Soledad Manalac-Morales,* Philippines, Pediatric Department of the Bellevue Hospital, New York University; *M. Vera Buhrman,* South Africa, Rochester Child Health Project, Mayo Clinic; *Alfonso Cardenas,* Colombia, Children's Hospital, and Department of Pediatrics, University of Louisville, Kentucky; *Eugenia Rosemberg,* Argentina, Harriet Lane Home, Johns Hopkins Hospital; and *Jamil Kheder,* Iraq, Children's Hospital, Columbus, Ohio.

The John Scott Award, established in 1816 "for ingenious men and women who made useful inventions," was presented this year to Frank W. Caldwell, director of research at the United Aircraft Corporation of East Hartford, Connecticut. Mr. Caldwell received the award for his work in developing the controllable pitch propeller.

Fellowships

The Marine Biological Laboratory, Woods Hole, Massachusetts, through a grant from the Lalor Foundation, is offering a limited number of postdoctoral fellowships in the fields of biochemistry, biophysics, and physiological chemistry. The fellowships are designed primarily for young scientists desiring to work during the summer on investigations for which the opportunities provided by the laboratory are particularly appropriate. The stipend is intended to cover laboratory fees, travel, and living expenses at Woods Hole. Applications should be received by *December 31.* Blanks and further information may be secured from the director of the Marine Biological Laboratory.

The National Heart Institute of the U. S. Public Health Service has inaugurated a research training program in enzyme chemistry with particular reference to heart muscle at the Institute for Enzyme Research of the University of Wisconsin. David E. Green, professor of enzyme chemistry, is the program director. Candidates must possess a Ph.D. or M.D. degree in order to qualify. Stipends for research trainees conform to those in effect for postdoctorate research fellows of the Public Health Service. The training program will include full-time research in some phase of enzyme chemistry and a regular series of lectures by members of both the institute's staff and other departments of the university of Wisconsin, and by guest lecturers from other universities. A trainee can start the program anytime between October 1949 and October 1950. The period of traineeship is 12 months; the number is limited to 10 each year and may include senior investigators. Application forms may be obtained from the Institute for Enzyme Research, Madison, Wisconsin. Completed applications should be submitted in duplicate to Dr. Green.

Stanford University has announced the establishment of a fund to provide five fellowships in aeronautical engineering. Known as the **Milton Reynolds-Bill Odom Fellowship Fund,** it was begun by Milton Reynolds, manufacturer of electronic equipment, and has received a supplementary gift from the Chicago section of the American Society of Mechanical Engineers.

Meetings and Elections

The 15th Conference of the International Union of Chemistry was held at Amsterdam September 6–10, under the presidency of N. R. Kruyt. Raymond Delaby, of Paris, is the general secretary of the union.

Nearly 300 persons were in attendance, representing most of the thirty countries adhering to the union. Russia, although adhering to the union and represented at the London Conference in 1947, did not send delegates. Representation from countries under Russian influence was limited, but not entirely lacking. The U. S. representatives numbered 16: W. Albert Noyes, Jr., vice president of the union, Roger Adams, E. Bartow, Ralph Conner, Warren C. Johnson, I. M. Kolthoff, J. Murray Luck, H. F. Mark, H. Nutting, Emil Ott, Austin M. Patterson, J. W.

Perry, A. Silverman, E. R. Smith, Edward Wichers, and J. H. Yoe.

The principal administrative body of the union is a council, on which each adhering country is represented by two, four, or six delegates, the number being fixed by the extent of scientific activity in the country, rather than by its size. Thus Switzerland has six delegates, as have France, Great Britain, Russia, Sweden, and the U. S.

The work of the union is done by 20-odd commissions. Membership in these commissions is determined primarily by individual interest and scientific competence, rather than by geographical considerations. These commissions deal mainly with matters of international standardization in such things as nomenclature, symbols and terminology, atomic weights, and physicochemical constants. Certain commissions promote the standardization of procedures, both for measurements of constants and for chemical analysis, and there is an important commission on documentation. The last named commission held numerous sessions during the week in an effort to assist in maintaining the *Beilstein encyclopedia of organic substances* and the *Gmelin handbook of inorganic chemistry*. Both of these, of course, were crippled by the collapse of Germany. It is gratifying to report that *Beilstein* has a very good prospect of recovery, but the reluctant decision with respect to *Gmelin* was that the annual support of $100,000 estimated as required to continue the present plan of operation simply could not be provided and that a complete editorial reorganization was needed if this important work was not to fail.

Other commissions worked equally seriously, although with less time needed to complete their agenda. Altogether, probably fifty or sixty technical sessions were held, with results that indicate that the union, as reorganized after the war, has a good prospect of worthwhile accomplishment in promoting the science of chemistry, not only by eliminating sources of misunderstanding and confusion, but by positive actions of international agreement. In such a field as nomenclature, for example, the importance of the work at Amsterdam can hardly be overestimated.

The council voted to resume an earlier name, "International Union of Pure and Applied Chemistry," with the object of advertising its interest in technology, as well as pure chemistry. It also made plans for a sectional organization under such general headings as analytical, inorganic, organic, biological, physical, and applied chemistry. These plans are provisional, pending further study during the interval before the next general conference, which is to be held in New York and Washington in September, 1951. At that time the union will also sponsor an International Congress of Pure and Applied Chemistry, which is expected to attract an attendance of some thousands, by reason of the programs of scientific papers which will be presented.

The excellent reputation of the Dutch as hosts for international gatherings was fully upheld. A delightful program of entertainment was provided, including a reception by the government in the Rijksmuseum and a concert by the renowned Concertgebauw Orchestra. Arrangements for the reception of visitors and for the technical sessions, as well as for official entertainment, were flawless.

EDWARD WICHERS

AAAS Subsection Nd—Dentistry, will hold three sessions of papers dealing with research on growth and development of the face, jaws, and teeth from the anatomical, anthropological, biochemical, and physiological viewpoints, at the Hotel McAlpin, Friday morning, afternoon, and evening, December 30. All inquiries should be addressed to Frances Krasnow, 422 East 72nd Street, New York City 21.

The Plant Science Seminar, at its recent meeting at the University of Wisconsin, elected the following officers to serve for the year 1949–50: chairman, Elmer L. Hammond, University of Mississippi; first vice chairman, Heber W. Youngken, Jr., University of Washington; second vice chairman, Paul D. Carpenter, University of Illinois; secretary, Edward P. Claus, University of Pittsburgh. J. Allen Reese, University of Kansas, and J. Hampton Hoch, Medical College of South Carolina were elected to the executive committee.

The U. S. Pharmacopoeial Convention elected Lloyd C. Miller, director of the Biology Division of the Sterling-Winthrop Research Institute, Rensselaer, New York, as director of pharmacopoeial revision for the new decade. Dr. Miller will succeed E. Fullerton Cook, who has been chairman since 1920.

Deaths

William J. Rooney, 57, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, died August 31 at Tooele, Utah, from injuries incurred in an automobile accident. He had been conducting special seismic investigations in California for the past two months. Mr. Rooney was considered an authority on earth currents and resistivity and had conducted research work in Australia, Guatemala, Peru, Spain, and the U. S. in this field.

Lawrence Edmonds Griffin, 75, retired professor of marine biology at Reed College, died September 12. Dr. Griffin was an authority on the dogfish shark.

August Krogh, 75, physiologist, died at his home in Copenhagen on September 13. Dr. Krogh was best known for his investigations of the capillaries. He received the Nobel Prize in physiology and medicine in 1920.

William Sargent Ladd, 62, former dean of the Cornell University Medical College, died of a heart attack on September 17. Dr. Ladd was an attending physician to the New York Hospital, a consultant to the Department of Medicine of the Nassau Hospital Association, and a trustee of the Memorial Hospital and the New York Academy of Medicine.

Durwald F. Fisher, 61, horticulturist at the Department of Agriculture, Bureau of Plant Industries, Beltsville, Maryland, died September 18 of a heart attack. Mr. Fisher conducted extensive research in the handling, transportation, and storage of fresh fruits and vegetables.

Prize winners in the Third International Photography-in-Science Salon, the annual competition for scientists and photographers, sponsored by *The Scientific Monthly*, were announced September 25. Judges were Merle A. Tuve, of the Carnegie Institution, for physical sciences; Walter F. Jeffers, of the Department of Botany, University of Maryland, for the biological sciences; A. A. Teeter, of Charles Pfizer and Company, New York City, for chemistry; Emanuel Krimsky, of Polyclinic Hospital, New York City, for the medical sciences; and Alexander J. Wedderburn, of the Graphic Arts Division, Smithsonian Institution, for photography.

The prints will be on exhibition at the U. S. National Museum, Washington, D. C., October 3–31, and at the Annual Meeting of the AAAS, New York City, December 26–31. The exhibit will then go on tour of important scientific institutions in this country and abroad.

Prize winners in the black-and-white division were: *First:* L. L. Marton, chief, Electron Physics Section, National Bureau of Standards, Washington, D. C., for "Electron-optical shadow method, a new technique making it possible to photograph and study quantitatively electrostatic and magnetic fields of extremely small dimensions." *Second:* Bernard Henry Mollberg, University of Houston, Texas, for "Ventrosinistral view of dried chick embryo which has been plated with aluminum, revealing obscure details of surface anatomy." *Third:* S. B. Newman, Emil Borysko, and Max Swerdlow, National Bureau of Standards, Washington, D. C., for "Electron micrograph of thin section of cells in onion root tip." *Honorable mention:* Jose Oiticica, Rio de Janeiro (Guggenheim Fellow at the National Museum); Clyde T. Holliday, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Maryland; Charles J. Salat, Armour Research Foundation, Chicago; T. G. Rochow, American Cyanamid Company, Stamford, Connecticut; and C. O. Worden, Laboratory of C. A. Zapffe, Baltimore.

In the color division, the following won awards: *First:* Charles D. Oughton and Eugene C. Ricker, Battelle Memorial Institute, Columbus, Ohio, for "Xerographic developing process." *Second:* Chester F. Reather, Carnegie Institution, Baltimore, for "Implantation of 12-day human ovum." *Third:* Thomas C. Poulter, and Walter Lawton, Stanford Research Institute, Stanford, California. *Honorable mention:* D. H. Rowland, Carnegie-Illinois Steel Corporation Research Laboratory, Pittsburgh; R. Stradling, U. S. Pipe and Foundry Company, Burlington, New Jersey; and A. C. Walker and S. O. Jorgensen, Bell Telephone Laboratories, Murray Hill, New Jersey.

The contest, which was established to encourage and extend the use of photography as a basic research tool, will be continued in 1950.

An Italian public health survey is being made under the auspices of the Italian High Commissariat for Hygiene, assisted by the Rockefeller Foundation and the World Health Organization, to help the Italian government reorganize its public health services so as to take advantage of modern scientific methods in the prevention of disease and the maintenance of health. Such fields as tuberculosis, malaria, venereal diseases, maternal and child care, industrial hygiene and public health statistics are being surveyed by specialists lent to the Italian government by WHO and the Rockefeller Foundation. Among the consultants are Julie Backer, of the Central Bureau of Statistics, Oslo; Luigi Carrozzi, of the University of Geneva; Dr. Lembrez, director of Border Health Control for the Marseilles area; and J. E. McCartney, of London. The survey began in June and is expected to be completed late in September. Results will be reported to the special commission headed by Mario Cotellessa, of Italy, and J. B. Grant, director for Europe in the Rockefeller Foundation's International Health Division.

The Roscoe B. Jackson Memorial Laboratory will put into full effect this fall its program of cooperative graduate study which will make its research facilities available without tuition fee to qualified graduate students. Credits may be applied towards M.D. and Ph.D. degrees in biology, zoology, bacteriology, genetics, psychology, and allied fields. Cooperating graduate schools to date include Northwestern University, University of Chicago, University of Illinois, Johns Hopkins University, Harvard University, University of Michigan, Washington University, Cornell University, University of Rochester, Ohio State University, University of Maine, Pennsylvania State College, and Brown University. There are also assistantships available and the laboratory will aid students in securing predoctoral fellowships such as those offered by the National Institutes of Health and the American Cancer Society.

Abstracts of Vitamin Literature, published by the Association of Vitamin Chemists, is available at an annual subscription rate of $3.00 for four quarterly issues. The fee covers cost of handling, printing and mailing; all abstracting, compilations and editing are done on a voluntary basis by association members. The two preceding volumes are available as long as the supply lasts. Subscriptions should be addressed to Irwin Olcott, Dawe's Vitamin Oil Producers, Inc., 4800 South Richmond Street, Chicago 32.

Status of AAAS Meeting Reservations

The early and heavy demand for *single* rooms already indicates a potential shortage of this type of accommodations at the **116th Meeting of the AAAS in New York City,** December 26–31. There are plenty of hotel rooms but many have double or twin beds. Miss Sylvia T. Peltonen, Manager, Housing Bureau, New York Convention and Visitors Bureau, 500 Park Avenue, New York 22, who is in charge of room assignments, urges that, when possible, room reservations be placed by parties of two or more. This also has the advantage of a lower cost per person. Room reservation coupons will appear in the advertising pages of *Science* at frequent intervals.

Is There a Science of Instrumentation?

E. U. Condon, *Director*

National Bureau of Standards, Washington, D. C.

INSTRUMENTATION, as the word is used here, means the development and application of measuring devices which respond quantitatively to some physical property of a situation and give an output which depends on this property. The word instrument is often used in a broader sense, as when forceps are referred to as surgical instruments, but in this discussion it refers to measuring devices.

Nearly all of the progress of modern science and industry is directly traceable to the development and use of a wide variety of measuring instruments. With monotonous regularity people who discuss this subject quote Lord Kelvin's saying to the effect that one's knowledge of a subject is of a poor kind indeed unless one knows how to measure quantitatively the factors involved. Quoted often enough so that it now has the status of a cliché, this saying is nonetheless true.

With all this appreciation and understanding of the importance of measurement, the problem of devising suitable measuring instruments for use with different quantities and in different situations has, up until recent times, been left pretty much to individual scientific specialists to work out as best they can. But in recent years, especially in the past decade, it has come to be more and more widely recognized that the problems met in designing various kinds of instruments have a great deal in common. Because of the importance of these common elements there is a useful body of general doctrine and data which can be termed the science of instrumentation. Recognition of this fact has found expression, for example, in the founding and growth of the Instrument Society of America. The society is devoted to this over-all point of view on the design of measuring instruments—not on such an abstract philosophical basis that no particular results are attained, but rather in practical terms whereby the designer of an instrument for a particular purpose can derive maximum benefit from experience gained from other instruments which have been built, perhaps, for quite unrelated purposes.

This trend deserves to be more widely known and cultivated among scientists as a whole. Too often it happens that a man confronted with a measurement problem requiring instrumentation is such a specialist in the phenomena being studied that he is unacquainted with the mechanical, electrical, and optical design principles which enter into good design of his instrument and is impatient with them. He then works out a "gadget" to fill his needs as best he can and in many cases it depends greatly on the happy ingenuity of his machinist or glassblower. What the science of instrumentation is trying to do is to codify general principles and design data referring to instruments as a whole so that their design can itself be put on a scientific basis worthy of the scientific problems it is to help solve.

Instruments may be classified first as to whether the objects whose property is to be measured are discrete or continuous. For example, an instrument that measures the capacitance of a large number of small condensers, one by one, is measuring a discrete property, and one that indicates changing hydrostatic pressure is measuring a continuous property. Evidently all instruments of the discrete class have a great many problems in common with regard to the mechanism for feeding in the objects to be measured, independently of what quantity is measured, and the same is true of all instruments responsive to a continuous variable.

Of the instruments for discrete measurement, perhaps the simplest is that which merely counts the total number of events or objects to which it responds. In nuclear physics it has been necessary in recent years to develop electronic circuits capable of counting objects at very rapid rates. In these the object or event is made to give rise to an electrical pulse fed to a scaling circuit and eventually to a mechanical register. Such techniques will undoubtedly find application in many other fields, such as in counting blood cells in a blood sample and in automatic digital computing machines.

Second, an instrument can be classified as to the nature of the element in it which is sensitive to the quantity to be measured and the nature of the response made. Such a sensitive element is known generically as a *transducer,* since it changes a physical quantity of one kind into another. For example, temperature measuring devices are made which depend on (a) the differential expansion of two solids, producing elastic deformation of them, (b) differential expansion of a solid vessel and a contained liquid, producing relative motion, (c) change in electrical resistance producing an electrical output signal, and many others.

At first sight it may seem that the sensitive elements used for different quantities are so various as not to have much in common. If this were so there would be no general basis to the science of instrumentation. But it is not so. Every sensitive element gives some kind of output quantity Q (such as a linear motion to be observed visually or an electrical voltage to be dealt with appropriately in another part of the instrument). Let x be the physical quantity to be measured. It is a general characteristic of all responsive elements that they possess properties that need to be considered in design of an instrument independently of the physical nature of x and Q. Among these are (a) *sensitivity,* the quantity $Q'(x)$, giving the rate of change of output with change of input under steady equilibrium conditions, (b) *unsteadiness,* the measure of the fluctuation in output $\overline{(Q-Q_0)^2}$ given by the transducer under a steady value of x due to looseness and erratic disturbances inherent in the situation, (c) *sluggishness,* the measure of the time rate at which Q assumes its new equilibrium value Q_1 from the value Q_0 when x abruptly changes from x_0 to x_1, and (d) *hysteresis,* which is a shortcoming of some transducers whereby Q is not dependent on x alone but on the past history of all values earlier assumed by x, and (e) *permanence,* the quality whereby $Q(x)$ retains its constant functional form over a long period of time whether the instrument is in use or not, thereby maintaining the instrument's calibration.

Evidently the design principles involved in specifying these characteristics of a transducer are quite general and will have similar limiting effects on the performance of the instrument no matter what the nature of Q and x. And as soon as we are past the transducer, evidently, we are dealing with the physical quantity Q instead of x. Hence from here on the design principles involved do not depend in any way on the physical nature of the quantity to be measured. In passing it may be remarked that sluggishness is not always an undesired element in a transducer, for sometimes the quantity which it is really sought to measure is not really variation of x at each instant, $x(t)$, but some sort of moving time average like

$$\bar{x}(t) = k \int_{-\infty}^{0} e^{-k(t-\tau)}\, x(\tau)\, d\tau$$

which is based essentially on the values of x in the past for a time of the order of $1/k$.

The next essential part of the over-all instrument may involve some sort of further transformation or amplification of the transducer output Q, as when the optical image of a linear movement is projected with enlargement on a screen, or when an electrical voltage is passed through a transformer. Evidently the design data for such devices will depend solely on Q, not at all on x, and therefore will be the same no matter in what branch of science or technology the instrument is to be applied.

The last part of the instrument involves the transformation of Q into some sort of indicating, recording, or control mechanism, depending on the use to be made of the data the instrument provides. Where indication is desired for individual readings or continuous observation, the coupling to the observer's sensory equipment is usually made through the sense of sight. Usually the indicating device involves the motion of a pointer relative to a scale, the position being noted visually by the observer. This led Eddington to regard all science as the systematization of relations between pointer readings obtained in various ways. This favored position of the sense of sight arises from its great sensitivity and resolving power. But one could also devise instruments in which, for example, the output, dependent on the quantity to be measured, controlled the pitch of a sound heard by the observer.

The transforming and amplifying elements of an instrument, as well as the indicating elements, need to be judged according to the same kind of qualities as were listed for transducers. In the over-all analysis there is nothing to be gained, for example, in having very little sluggishness in the transducer if the indicating element has much sluggishness.

A particularly simple kind of indication is that of the "go—no go" variety, which simply gives a signal if x is greater or less than preassigned limits or lies outside a preassigned range.

A recording mechanism is an element that gives a material record of the variation in x observed by the instrument. This is usually in the form either of a continuous curve drawn on a strip of paper or of a discrete series of digital numbers stamped on a strip. But it need not take either form and might be a magnetized tape with the output coded on in some way. Such a form would be applicable where some computing needs to be done on the output data by an automatic computer arranged to accept data on a magnetized tape as its input. The design considerations involved in a recording mechanism may be quite independent of the nature of the quantity x that is being measured.

Finally, a control mechanism is an element that takes the output, which may also be given presentation by an indicator or recorded in a recorder, and uses this to actuate some device in the original situation affecting the value of x. In the simplest case it is desired to have the control mechanism provide a situation which leads x to assume a constant value.

But it is only slightly more complicated to require that x follow some preassigned functional variation with time. Here all sorts of new problems present themselves, such as the tendency of the system to "hunt," that is, for the correction action brought into play by the control to produce greater effects than needed to bring x to the control value $f(t)$.

In more complex cases there may be more elaborate combinations of the basic instrument elements, as when several transducers respond to several quantities $x_1, x_2 \ldots$ and the signals so obtained are combined mathematically in some analogue or digital computer to produce one or several output quantities $z_1, z_2 \ldots$ which may actuate a control mechanism. Also it may happen that the output does not actuate a control mechanism related to the system being measured but actuates another device which maintains a prescribed relationship to that system. Thus, a gun director's input is optical or radar data about position of a target, but its output does not act directly on the target to control that position, but on a gun with the object of aiming it so as to launch a projectile which will hit the target.

Enough has been said to bring out the fact that in modern complex instruments a large part of the instrument is independent of the nature of the quantity to be measured. It is this fact that is giving rise to the recognition that there is a science of instrumentation concerned with these common elements and their systematic study and improvement. It seems quite likely that the instrument scientist will in the future play a role of steadily increasing importance in the development of all the sciences. It is a profession that should lend itself to specialization and workers in all fields should be relieved as much as possible from the distraction of having to devote too much attention to the detailed design of instruments for their particular needs.

In accord with these general ideas, the National Bureau of Standards is planning a program that will give just this kind of over-all study to the basic problems of instrumentation in all the physical sciences. Up to now, corresponding to the older and still common practice, instruments have not been considered from the general viewpoint, but separate and uncoordinated attention has been given to mechanical, optical, electrical, and electronic instruments in different parts of the organization. The program is being planned in cooperation with the Office of Naval Research and with research groups in the Army and the Air Force.

The objectives of this program are three: (1) systematic analysis of available methods and devices in terms of their precision and reliability; (2) studies of materials, components, and elements which are now known to impose serious limitations on instrumentation; and (3) development of specific instruments not now available.

Under the first heading, as part of the process of reviewing the literature, some particular limited field in which specific instrumentation problems are of interest will be studied. Careful analysis at this stage of how related measurement problems were solved in the past, of available related instrumentation, of its precision, and of the materials involved, will establish a basis for actual development work and provide critical data on the status of instrumentation in this field. Over a period of years, this approach should not only yield the concrete instruments needed—a need determined in this case by the cooperating agencies—but also accumulate information in a systematic manner, permitting a logical approach to subsequent problems.

Present demands for instrumentation improvement are essentially twofold: higher sensitivity and faster response. These are necessary because the time intervals with which present day work is concerned are extremely small, only minute displacements may be allowed, and the signals are low in power. In general, sensitivity can be increased if the time during which phenomenon is under observation is increased, but this often cannot be done because the existence of the phenomenon may be of short duration—as in, for example, nuclear and cosmic physics and in the study of biological cells. At the same time, noise level becomes a serious limiting factor where signals are weak.

In spite of these incompatible objectives, instrumentation is succeeding in extending sensitivity and signal response, but in the process large quantities of complex data are the result, creating the problem of processing such information. Here other instruments, whose functions are the orderly and integrated presentation of data, are needed. Recording devices are typical of this class of instruments, but more sophisticated types are necessary now for the analysis of large amounts of data, the performance of predetermined operations, and the presentation of the summarized findings, discarding unwanted background. Fortunately, machines like electronic digital computers, originally planned for solving mathematical equations, afford a means of attaining this end. Specific problems to be considered in the program of the National Bureau of Standards include transducers, electron optical field mapping, data transmission and reduction, improved microscopes, and so on. Work on some of these is already in progress. Coincidentally, the bureau's program in electronic digital computers is continuing: two machines are under construction in its laboratories in Washington and Los Angeles, while another five are being built by contract with private laboratories and industries.

One aspect of instrumentation, already mentioned, is the problem of materials and components. Related to this is the existence of principles of measurement whose application cannot be realized until developments in another field of science are achieved. Thus, electron optical field mapping represents an application of principles in optics to electronics, yet the realization of this important research tool had to wait until the science of electronics had advanced to its present state. An illustration of the dependence of instruments on materials is the wire strain gage. The principle was known as long ago as Ohm's law. Yet it was not until Simmons, Ruge, and De Forest developed methods of bonding the wire to paper and ways had been found to measure and record small changes in current that the principle was applied successfully. It is for these reasons that the study of materials and components, as well as the study of past methods proposed for measurement problems, is an integral part of the bureau's program.

The need for cross-channelling information in the sciences has grown acute in recent years. When it comes to instrumentation, this need has two aspects: basic developments in one field may provide the basis for instrumentation in another field and instruments developed in one field may have applications in others. As an illustration of the first aspect, scientists in the bureau's radio propagation laboratory recently developed and constructed an atomic clock which has remarkable precision. The heart of the development is the application of the knowledge of reasonance absorption in atomic physics and of microwave radiofrequencies to the problem of time. Again, the bureau has developed a standard of length based on the green line of mercury 198. This development depended on knowledge of atomic and nuclear physics, while the realization of the instrument and associated apparatus is a combination of knowledge in electronics and optics. An analogous story could be told about the recent measurement at the bureau of the magnetic moment of the proton. Here there is, at least in part, with excellent possibilities for full development in the future, the basis for atomic standards of the three basic measurements—time, length, and mass.

Indicative of the importance of cross-channelling information concerning instruments is the bureau's experience with diamonds as tools for measurement. Many years ago the bureau was interested in diamonds for ruling lines on precision scales, and devices and methods for cutting diamonds were successfully developed. The same group of scientists devised a diamond indentation method of hardness testing, which has been standardized and is used in the Tukon tester.

In the course of this work, scientists engaged in the study of aircraft cylinder wear, who had been using conventional measurement methods, recognized the possibility of determining cylinder wear by the change in length of a series of standard indentations, using diamond indentation. Modifications were needed, and a special instrument was developed capable of measuring wear to a precision of 0.00002 inch and of detecting even smaller amounts. Auxiliary developments continued in such fields as the cutting of diamonds and the drilling of small diamond dies for fine wire production.

These examples not only indicate the need for wide dissemination of information among the fields of science but reinforce the concept that instrumentation is a science in its own right. There is no reason why the practitioner of this science, conceived of as the logical approach to measurement problems, cannot provide measurement devices of a given type for a variety of fields. Certainly this would save the experimentalist much time and effort. Prior to this century, an analysis of the experimentalist's activity might have shown that the bulk of his time was spent in getting ideas and in analyzing the data of his subsequent experiments while a minimum of time was spent in the construction of instruments. In the present period, too often the scientific situation is such that the bulk of his time has to be spent in devising and constructing his instruments. From the point of view of research, this is unfortunate; and it is here that the science of instrumentation can make significant contributions not only to instrumentation as such but to the progress of original research.

Operational Aspects of Instrument Design

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Of wonders of science and feats of design
Has many a scribe writ the praise;
And if I now mention the subject again
It's distinctly a relative phase
For while science and gadgets are fine in their ways
One worries at times 'bout their clutch,
Especially when science, design, and math'matics
Combine to get us in Dutch.

THE AMAZING RELIANCE today on implements and machines, particularly on those trust in what they do or tell us were well we term *instruments,* and our unquestioning described a few years ago by Hugh L. Dryden, then associate director of the National Bureau of Standards (now director of aeronautical research, National Advisory Committee for Aeronautics) in an address before the Instrument Society of America (*2*):

> A significant, astonishing, and typical phenomenon of modern times is the general confidence placed in the readings of any well-constructed instrument. The automobile driver swears by his speedometer; the housewife looks at the thermometer to see whether she ought to feel too warm or too cold; the handsomely ornamented dials in the lobby of the skyscraper convincingly prove that the wind is blowing 60 miles per hour from the northwest on the roof. Even engineers who should be more skeptical have contracted the habit of relying on the readings of instruments. This naive faith has in general been justified by the care which the instrument industry has exercised in the control of the accuracy of its products. Nevertheless, this great faith in the readings of instruments should continually remind us of the responsibility resting upon us to justify that faith, to make more accurate instruments, which hold their calibration under severe conditions of service, and which are most nearly foolproof in operation. We have an obligation to promote the correct use of instruments in a manner to secure uniformity and mutual understanding.

Dr. Dryden justly stresses our indebtedness to the instrument industry for the care it "has exercised in the control of the accuracy of its products." He does not mention, however, either in the passage quoted or elsewhere in his address, the enormous influence exerted upon the instrument industry by the mass experience of the many users of instruments produced in quantity and employed under a great variety of conditions—a mass vote that expresses experience so vast that even the improbable has plenty of chance to occur and usually does. If the design of an instrument released today is faulty in even the slightest degree, you hear about it tomorrow, or at most, the day after tomorrow. It is this combination of mass vote registering a vast experience and a demonstrated manufacturer's responsibility that justifies our faith in these instruments.

In the case of instruments of which only a few are produced, and of instruments (e.g., military contrivances) produced in quantity for use under extraordinary conditions that are difficult or impossible to simulate, our trust in the instruments rests on less firm foundations—it rests largely on extrapolation from commonplace experience bolstered by faith in the manufacturer's ability to design and produce an instrument that will do the job intended under the conditions of actual use. When the designer and producer of the instrument are far removed from the ultimate user not only geographically but also in experience and perspective, too often the case and sometimes unavoidable, then our faith may be really unwarranted.

The more complicated the instrument, the severer or stranger the conditions of use; the less we know about the eventual operator of the instrument, the more acute are the problems of instrumentation. While these problems do occur in the design of laboratory instruments, they are more frequently critical in the design of control devices—instruments which measure the values of a number of variables (with or without the intervention of a human operator) and which react in a predetermined manner to establish a prediction for control purposes.

An excellent example of the difficulties which the Operational Analysis Groups of the Air Forces encountered was the first group of automatic sights of World War II, designed for the defense of bombers against fighters. From the strictly instrumental point of view, which necessarily precluded field studies, these computing sights were clever mechanisms for determining the amount of deflection required (a "lag," not a "lead," when the fighter was following a pursuit-curve course toward the bomber). The computation was based on the observed angular velocity of the fighter relative to a coordinate system based on fixed directions within the sight's mount, which was firmly fastened to the bomber's frame and not gyro-stabilized. The component of this relative motion pertinent to the deflection problem is the motion of the fighter relative to a coordinate system determined by the velocity vector of the bomber, the vertical plane (i.e., the plane through the zenith and through the bomber's velocity vector), and the plane through the bomber's velocity vector perpendicular to the vertical plane (which will be horizontal if and only if the bomber's velocity vector lies in the horizontal plane). Unfortunately, as a result of the pitching, rolling, and yawing of the bomber, there is generally considerable motion of the sight-mount coordinate system relative to the coordinate system determined by the bomber's velocity vector. This motion is, of course, irrelevant to the deflection problem. Consequently, in the absence of gyrostabilization of the sight mount or an adequate "smoother" within the computer to iron out the irrelevant components of motion, these sights merrily computed deflections with comparatively great exactitude but on the basis of largely irrelevant data. It didn't take experienced gunners long to discover this fact in actual practice. As a consequence these computing sights were torn out of the bombers in the combat theaters, and for a time the whole program of development of automatic computing sights for aerial warfare was seriously discredited.

Here there were remedies available to the instrument designer—gyrostabilization of the sight mount, a built-in smoother, or both—but cases do exist where uncontrollable external conditions limit the realizable precision of a high precision instrument to a far greater extent than do the more evident limitations on the design parameters involved. A case in point is the optical range finder (*2*). In effect, this instrument measures the angular parallax, α, of the target when viewed from the two ends of a base of length b contained within the instrument, the scale of the instrument is graduated to read range, r, directly, and the graduations are based on the equation $r = b/\alpha$, where r and b are in the same units (e.g., feet, yards) and α is in radians. An error of $\Delta\alpha$ in the measurement of the parallactic angle produces, therefore, an error of $-(r^2/b)\Delta\alpha$ in the measured range. Range finders have been built with base lengths as small as 20 inches and as great as 100 feet. Turret range finders on battleships have base lengths of 50 or 60 feet. A typical American instrument for use against airplanes has a base length of 13½ feet. The ratio of the range to be measured to the base length is generally so large that satisfactory accuracy cannot be obtained unless the parallactic angle can be measured with an error not greater than two or three seconds of arc. To lessen the errors due to the limited acuity and resolving power of the eye, range finders are usually equipped with an eyepiece of magnification M, the effect of which is to transform α into $M\alpha$ for purposes of measurement. Thus an error of δ in the apparent angle so measured becomes an error of δ/M in α. From this error relation and the basic one given previously relating errors in α to errors in r, it would seem, and it has often been tacitly assumed, that an increase of magnification by a given factor, or an increase in base length by the same factor, would be equally effective in increasing the precision of the instrument as a *range* finder; and that by sufficiently increasing the magnification, or the base length, or both, any desired precision in terms of *range* could be achieved. Unfortunately, convection currents in the air between the range finder and the target—there is always some quiver and sometimes a veritable "boil"—invalidate these conclusions. From studies conducted under the auspices of the OSRD during World War II and some more recent investigations carried out by F. E. Washer and his associates at the National Bureau of Standards, it now appears (*2*) that any single measurement of the parallactic angle, α, has a standard deviation component, perhaps between 0.80 and 1.20 second (1 second = 0.000005 radian), that originates in the air path between the range finder and the target, and consequently is beyond the control of the instrument designer. By substitution in the basic error relation given earlier, the corresponding standard deviation component of a range estimate of a given range using a particular base length can be determined. Thus, taking 1 second as a typical value of the standard deviation component (due to shimmer) of a measurement of α, the corresponding range standard deviation will be 1 percent if the range is 2,000 times the base length and 5 percent if it is 10,000 times the base length; and this amount of uncertainty will be present even if the range finder and the observer contribute no additional components of error (a purely hypothetical situation!). The instrument designer can offset this component of error only by making the base long enough to achieve the precision required at a given range, if practical considerations will allow him to do so.

Up to this point we have considered only cases where "external conditions" in themselves prevent full realization of the built-in accuracy and precision of the instrument. Let us now consider some instances where the human operator of the instrument is the stumbling block. These human troubles can be of two kinds: *physiological* and *psychological*. In the case of the optical range finder the limited resolving power and limited acuity of the observer's eye are physiological limitations. The limitations of coincidence judgment produce a standard deviation component in the *apparent* field, perhaps of the order of 3 seconds. In terms of the measurement of the parallactic angle, α, this becomes a standard deviation component of $3/M$ second. Combining this with an air-path component of about 1 second, as just considered, the contribution of these two sources of error to the standard deviation of measurement of the parallactic angle, α, is $\sqrt{1+(3/M)^2}$, which for commonly used magnifications of 8, 12, and 24 diameters equals 1.068, 1.031, and 1.008 seconds, respectively. From these figures it is evident that the air-path component completely dominates the situation, and that by using readily accessible magnifications the contribution resulting from the aforementioned physiological limitations of the observer can be rendered negligible. Unfortunately, this is not the whole story, for use of high magnifications introduces a psychological difficulty in the form of observer frustration resulting from the shimmy of the target image—the quiver of the target (as seen through the air path from the range finder to the target) *magnified M times* by the lens of the eyepiece. Indeed, if the magnification involved is 20 or 24 diameters and the air path is "boiling" vigorously, which is the situation on hot days, the observer may be unable to "observe" at all, that is, unable to bring the target image and the reticle of a stereoscopic range finder (the two target images of a coincidence range finder) into "coincidence."

A strictly psychological difficulty arises in connection with the *stereoscopic* range finder. In making a setting with a stereoscopic range finder the reticle and target are brought into coincidence by turning the range knob. "If . . . the target is extended or against a background so that there is no free space on either side of the target, then when the reticle is projected beyond the surface of the solid object the observer is loath to accept the apparent penetration of the reticle into the solid target, and hence a bias is introduced which may correspond to a large error in the indicated range. Similarly, when one attempts to set a crisp, sharply defined image of the reticle in stereoscopic coincidence with a target not sharply defined and obscured by blue haze, the pronounced difference in atmospheric perspective leads to an erroneous setting. These errors resulting from biased stereoscopic judgment may amount to as much as five or six seconds [in the measurement of the parallactic angle, α]. If one attempts to check the graduations on the scale of a range finder by reading ranges on a selected series of terrestrial targets at known distances, the stereoscopic bias for the different targets will, in general, be different for the different targets, giving a jagged calibration curve which suggests that individual graduations on the scale are displaced from their correct positions in a nonuniform manner. The falsity of this conclusion can be shown by testing the range finder with a better planned test in which stereoscopic bias is eliminated or equalized for the different targets" (*3*). The seriousness of this psychological source of errors is readily appreciated when it is recalled that satisfactory range measurement generally requires measurement of the parallactic angle with an error not greater than two or three seconds. Fortunately, there is a design trick (*2*) used in the German R40 range finder whereby bias from this source can be averaged out by making two settings on the target, and this may be used for range reading on stationary or slowly moving targets.

The automatic computing sights mentioned earlier were plagued also with operator errors of psychological, or psychophysical, character arising from the interaction of the operator and the instrument. In the first place, the several motions the operator had to perform were somewhat unfamiliar and awkward, and cultivation of adequate skill by intensive training was necessary. With one type of these devices the operator moved the gun mount (upon which the sighting mechanism was firmly fixed) in azimuth and elevation by means of a handle-bar arrangement, one handle of which contained a pistol-grip trigger for activating the gun(s), while rotation of the other handle adjusted the range setting of the sight. It was difficult enough to learn how to perform all of these motions correctly to begin with. To be called upon to perform them correctly in the excitement of an attack, lasting 5 seconds or less, was asking too much! (How many persons can *pat* their heads, *rub* their stomachs, and *scratch* a stomach itch all at once, without getting mixed up? The gunner's problem was even worse!) To make matters still worse, the reticle of the sight was controlled by the computing mechanism and was not under direct control of the gunner—the most amazing changes of position of the sight reticle would result at times from a simple movement of the hands.

There exists today, largely as a result of such wartime experiences, a branch of applied science known as *human engineering* (called by the inner circle "psychophysical systems research") that is actively concerned with "man as a worker of machines, and with machines as things that man must work." This aspect of instrumentation deserves close attention from both designers and users of instruments.

Although the instrument in hand may be able to perform its intended function with great accuracy and precision, this built-in accuracy and precision may be highly illusory in terms of the uses to which its end product are to be put (e.g. measurements for direct use as such in scientific research, engineering tests, and so forth; or measurements constituting the stimuli activating an automatic control device). Thus high speed punch card equipment is fine for processing statistical data to obtain accurate summary figures with ease and rapidity. But the trustworthiness of these summary figures for purposes of administrative action or scientific inference depends upon the trustworthiness of the raw data themselves for these purposes, which in turn hinges upon the extent to which the method of obtaining these data effectively produces random samples from the population to which the conclusions are to apply. The capabilities of these machines, which bring the processing of very large amounts of data within the realm of practicability, carry with them the danger of diverting attention from the need for considering carefully in the planning stage of an investigation (a) exactly *what kinds* of data are required for the purpose at hand, (b) *how* they are to be collected, so as to assure validity for this purpose, and (c) in *what quantity* they will be needed in order to achieve adequate precision. The approach "Let's record everything in sight and the machine will do the rest" is not to be recommended, for when the data are in and are partially or fully analyzed it is too often found that "everything in sight" failed to take account of factors critically affecting the value of whatever conclusions might be reached.

Finally, the great practical value of many instruments stems in the last analysis not so much from the high precision of individual observations thereby attainable as from the fact that they make it possible to obtain broad coverage with observations of ample precision. For example, consider the core-boring instruments and associated techniques developed by the Bureau of Customs and others for evaluating the clean-wool content of a shipment of baled wool. In the case of many carpet wools the relation between the between-bale and within-bale components of variation of the clean-wool content is such that accurate evaluation of the (average) clean-wool content of the entire shipment requires the sampling of many bales, taking adequate amounts of material from each bale sampled. This is made possible by the core-boring tool. Without it, the cost of obtaining the same intensity and coverage of sampling by breaking open the bales and drawing samples by hand would be prohibitive and would necessitate relaxing accuracy requirements below levels considered desirable. As another illustration, consider the Magne-gage designed at the National Bureau of Standards to measure the thickness of nonmagnetic coatings on a magnetic metal object. By its use the total thickness of composite coatings ranging from 0.0005 to 0.003 inch can be determined rapidly and nondestructively to within about 10 percent; and the thickness of each component layer of similar coatings, to within about 15 percent. The important feature is that the determination is nondestructive *and* rapid, so that many different parts of the coated object may be examined when the quality of a coating or the effectiveness of a coating technique is being evaluated.

To sum up: From prehistoric times man has been a user and developer of tools. Man now depends more than ever on implements and machines—some crude, many elaborate; some delicate, others sturdy; all the servants, and some at times the masters, of man. Thomas Carlyle said: "Man is a Tool-using Animal. . . . Nowhere do you find him without Tools: without Tools he is nothing, with Tools he is all" (*1*).

But if our instruments are to serve their purposes fully—and this is especially true of modern, complex control devices—both the designer and user must never forget (1) the conditions of operation, (2) the nature of the measured quantities, (3) the relation of these quantities to the end action, and (4) the psychological and physical characteristics of the operator. With these elements in mind, instrumentation will progress, providing man with ever-increasing extension of his senses and control over his environment.

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Reports of Meetings on Instrumentation

The Fourth Annual Conference and Exhibit of the Instrument Society of America

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Sixty-five technical papers presented at 23 sessions, five cooperating societies; 8,000 in attendance, 150 exhibitors showing $6,000,000 worth of new or improved instruments, components or accessories, spread over 20,000 square feet of the huge Municipal Auditorium in St. Louis—these are the bare statistics of the week-long conference and exhibit of the Instrument Society of America, held September 12–16.

One of the youngest and fastest growing of the technical societies, the ISA brought together at St. Louis, in this field of common interest, several other scientific and engineering societies. The Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers had two sessions; the American Institute of Electrical Engineers two; the American Institute of Physics two; and the National Telemetering Forum two. Members of any of these cooperating groups (or the Institute of Radio Engineers) were admitted without charge to all sessions, as well as to the exhibits.

In general, the problems of measurement and control in any branch of experimental science or industry require for their solution the design, development, selection, adaptation, procurement, understanding, and use of measuring devices and techniques. This, broadly, is the field of instrumentation, the art and the science of measurement and control. The promise of this newly recognized branch of applied science lies in the universality of its contributions—it is an indispensable and integral part of all of the specialized sciences, and any discovery or improvement of devices and techniques for measurement and control of any physical quantity can find immediate application in many unrelated specialties of science or engineering. Its strength lies in the universality of its sources of progress—the operating principles of measuring devices are drawn from all the basic fields of science, and any discovery or advance in any field is likely to find eventual or immediate application in a new or improved device for use in still other fields.

Within the last decade or two, the growing complexity of science and technology has made it impossible for the engineer or scientist to keep abreast of instrument developments and measuring techniques in other fields. Hence, the emergence of the new science of instrumentation and its practitioners, specializing in cutting across specialties and cross-fertilizing all the sciences.

The Society. The ISA was formed in 1945 as a combination of a number of local instrument societies in various centers of industrial or scientific activity, and now has 34 sections in the United States, two in Canada, and one in Netherlands West Indies, with a membership of over 3,000.

The objective of the society is "to advance the arts and sciences connected with the theory, design, manufacture and use of instruments in the various sciences and technologies." The various sections hold regular meetings and national meetings are held twice yearly: the spring meeting for a one- or two-day period, and the annual conference and exhibit for five days, during the first half of September. The location changes each year. The society publishes the *Proceedings*, containing papers presented at ISA sessions during the annual conference, and also edits a special "Journal" section of the monthly magazine, *Instruments*, which each member receives. Special publications are proposed by the working committees of the society, of which there are more than a score. ISA officers for 1950 are: R. Piggott, president; A. O. Beckman, J. B. McMahon, Nelson Gildersleeve, and Porter Hart, vice presidents; Hugh Ferguson, treasurer; and Richard Rimbach, executive secretary.

The Conference. Conferences are much alike, whether the papers relate to star spectra, enzymes, or automatic control. People drift in and out, talk to colleagues in the halls, ask a few questions on the floor, and grill the speakers later in small groups.

The ISA papers were available in preprint form, which made for better discussion. There were sessions on maintenance and operation, inspection and gaging, instrumentation for production processes, transportation instruments, instrumentation for testing, and analysis instrumentation. A symposium was held on rockets and jets and a number of papers in the session on instrumentation for testing related to the currently "hot" problem of testing rockets and jets. Speakers at all sessions were allowed at least twenty minutes, and in some sessions up to an hour. Attendance ranged from one hundred to four or five hundred. Some of the papers were summarized especially for *Science* by the authors and are presented elsewhere in this issue.

At the annual business meeting a paper was presented on "Instrumentation Flow Plan Symbols," by David E. Hostedler (Foster-Wheeler Corp., New York), as illustrating outstanding work done by a subcommittee of the Recommended Practices Committee.

On the weekend preceding the conference, the ISA, in cooperation with a number of manufacturers, sponsored an "Instrument Maintenance Clinic" for instrument technicians, which proved extremely popular. The conference sessions on instrument maintenance and operation were also well attended. A panel discussion was held on "Instrument Mechanic Training."

The Exhibit. The hundreds of instruments and components displayed or demonstrated at the exhibit received careful inspection and study from the engineers, scientists, technical men, purchasing agents, and industrialists in attendance.

No catalog of the products displayed could convey the educational value of the exhibit. The variety of exhibits precluded any monotony: miniature ball bearings, large 10-in. control valves, recording spectrophotometers, glass thermometers—any of those might be found in the booth next to electronic vibration devices, or an X-ray diffraction equipment.

The big manufacturers of indicating and recording instruments were all represented by large displays. The large number of control components and instruments reflected the fact that the process industries (chemicals, petroleum, metals, etc.) furnish the largest base for the instrument industry, and for the membership of the ISA.

Significant of the role of advanced instrumentation in industry was the showing of soundly engineered commercial products such as the recording spectrophotometer with nearly 100% automaticity, supersonic generators and materials testing devices, computing mechanisms, X-ray diffraction equipment, etc., which only a few years ago were new in the research laboratory, as rough experimental models.

Instruments for measurement and control of flow, temperature, time, and chemical concentration, were much in evidence. But electronic, radioactive, geophysical, and mechano-electronic devices were also shown in profusion: the mass spectrograph leak detector, vibration pickups, roughness indicators, accelerometers, etc.

Various agencies of the government had been invited to participate in the exhibit. The Department of the Navy was represented by the Bureau of Ordnance, the Naval Ordnance Laboratory, the Naval Ordnance Test Station, and the Bureau of Aeronautics. The National Bureau of Standards also had an exhibit. One of the most striking Navy exhibits was a radio tracking equipment (Raydist), recording in the booth the location of a boat cruising up and down the Mississippi, carrying a transmitter. Another was an X-ray planigraph, in which the object being X-rayed was oscillated in a complicated motion during exposure. The resulting picture showed clearly the details of structure in a certain selected plane within the object.

It is to be hoped that, in the future, participation of such agencies as the Public Health Service, the Atomic Energy Commission, and the Bureau of Reclamation will be obtained, to bring the instrument developments in these fields to the attention of the technical public and give stimulus to joint attacks on special measurement problems.

Participation of manufacturers of biological and medical equipment might be increased by arranging some joint sessions with the American Medical Society, perhaps, or the American Physiological Society. The problems of measurement in the study of the human body and its ills, in physiology, and in biology generally, may be sufficiently specialized, and are certainly sufficiently important, to justify inclusion of these fields in the area of cooperative effort of the ISA.

But the society, and the exhibit, are new: they will develop, and will emphasize, those fields in which the greatest interest is found. Each member of the AAAS who can do so should attend future ISA exhibits and participate in its conferences.

The 1950 conference will be held next September in Buffalo, N. Y.

Fourth Conference on Low Temperature Calorimetry

Daniel R. Stull

Dow Chemical Company, Midland, Michigan

The Fourth Conference on Low Temperature Calorimetry was held in Cambridge, Massachusetts, on September 10, during the meeting of the International Conference on the Physics of Very Low Temperatures. Both conferences met at the Massachusetts Institute of Technology and, because of the similarity of interests, each conference was attended by some members of the other group. The morning and afternoon sessions were attended by representatives of some 25 university, industrial, and government laboratories from Europe and the U. S. In the absence of Hugh M. Huffman, chairman of the previous three sessions of this conference, the meeting was presided over by Daniel R. Stull, of the Dow Chemical Company.

Herman L. Fink, of the U. S. Bureau of Mines, presented a report on thermochemical and calorimetric standards by the Subcommittee of the NRC Committee on Physical Chemistry. The report pointed out that by international agreement the absolute joule has been selected as the standard unit of energy. This unit may be transferred from the national standardizing laboratories to the investigator's laboratory by the use of appropriate electrical standards and in some cases by means of a standard substance which takes part in a chemical reaction. The report continued with recommendations bearing on the physical states and chemical changes involved in calorimetric measurements, and dealt more specifically with the problems associated with combustion calorimetry; specific heat of solids, liquids, and gases; and solution calorimetry, including heats of solution, heats of reaction, and heats of dilution.

In former meetings of this conference, three substances were chosen as standard materials for the comparison of calorimeters. Normal heptane (bp + 98.4° C, mp − 90.55° C) was selected as a liquid for the low temperature range, benzoic acid (mp + 122.36° C) as a solid substance for the same range, and synthetic sapphire for work at high temperatures. These samples have been prepared under the direction of Edward Wichers of the National Bureau of Standards, and the methods and precautions observed in their preparation were described to the conference by George T. Furukawa. They are now ready for issue, and are not regarded as part of the standard sample series of the bureau, but are reserved for the use of the conference and for related special purposes. Since the initial purpose of these samples is the comparison of the values of specific heat measured in different calorimeters and by different methods, and in view of the elaborate purification and high purity of the samples, it was the recommendation of the conference that the samples not be squandered by use as a calibrating substance, but used for the purpose of comparison. Hence, the above samples will be issued without charge by the National Bureau of Standards to any reputable laboratory agreeing to report the results of their measurements to the bureau. Requests for these samples should be made to F. G. Brickwedde, National Bureau of Standards, Washington 25, D. C. It was suggested that the results of these measurements and their comparison would be of interest to the conference at some future meeting.

A discussion arose over the merits of a fractional melting technique vs. a fractional freeezing technique as a method of purification. It was brought out that when thermal equilibrium exists, these two methods become identical.

John G. Aston described plans for reestablishing the temperature scale of Pennsylvania State College. Since 1933 the temperature scale of this laboratory has been based on copper-constantan thermocouples which are now about worn out. The new scale will be based on eight platinum resistance thermometers, and will be compared with a helium gas thermometer from 10° to 90° K. In close cooperation with the National Bureau of Standards, improved apparatus, particularly manometry, has been constructed, which Dr. Aston feels will decrease the departure of his scale from the true thermodynamic temperature scale to about 0.03°.

H. L. Johnston, of Ohio State University, mentioned some high pressure PVT (pressure-volume-temperature) work in progress in his laboratory which will yield improved virial coefficients of helium, and decrease their uncertainty to perhaps one third. Dr. Brickwedde pointed out that increased certainty in these virial coefficients would depend upon the value of the gas constant R. Drs. Johnston and Brickwedde then developed the facts that the thermodynamic temperature scale (based on a perfect gas) could be defined in two different ways: (1) the difference in temperature between two thermal states (say steam and ice) can be assigned a value; and (2) a value can be assigned to a single thermal state (say the ice point). Thus, either way, the whole scale will be fixed. Dr. Brickwedde remarked that the International Union of Physics at its last meeting had recommended that the temperature of the ice point be selected once and for all time by the International Bureau of Weights and Measures.

Another project of the conference aimed at unification of the temperature scales of the various laboratories engaged in calorimetry was the construction of forty platinum resistance thermometers (platinum thimble type) of one lot of platinum wire by the Leeds & Northrup Company of Philadelphia. These forty thermometers have been purchased by various laboratories, and are being sent to the National Bureau of Standards for calibration. By special arrangement, the bureau will calibrate these thermometers down to 11° K. Harold J. Hoge described the methods used to compare these thermometers with NBS standard platinum resistance thermometers previously calibrated against a helium gas thermometer. Dr. Hoge mentioned that up to the present time, sixteen of these thermometers have been calibrated from 11° K, two are in the process of calibration, and six are awaiting calibration.

F. W. Schwab and E. Wichers (*J. Res. Nat. Bur. Stand.*, 1945, **34**, 333) have developed a Pyrex cell containing benzoic acid for use as a secondary fixed point in thermometry. Dr. Hoge reported that to date more than sixty of these had been issued, and are certified ±0.003° C by the bureau. Experimental work is now in progress on new cells containing diphenyl oxide, tert-butyl alcohol, and normal heptane.

Dr. Hoge also described a special potentiometer in use by the bureau, and built by the Rubicon Instrument Company, of Philadelphia. This potentiometer will measure up to a total of 31 v with a precision of one part in ten thousand when measuring over one volt.

R. B. Scott described a new Simon type helium liquifier recently built at the National Bureau of Standards. It contains a stainless steel bomb of 1800-ml capacity surrounded by liquid hydrogen and in turn by liquid air.

J. G. Aston described a convenient helium liquifier recently built in his laboratory. The constructional features are such that the apparatus lends itself nicely to a variety of different experiments. At present it is being used to study the adsorption of gases on titanium dioxide. The equipment contains a Woods metal joint which is easily opened and closed vacuum tight.

E. F. Mueller, of the National Bureau of Standards, described two unsuccessful attempts to construct platinum resistance thermometers of 1.25-mil wire. He described two G2 Type Mueller bridges (constructed by Leeds & Northrup Company, of Philadelphia, for the bureau) containing resistors made of the new gold-chromium alloy which is reputed to have properties somewhat improved over manganin. He reported that a third such bridge has been built by the General Electric Company of Schenectady, New York.

New alloys are in prospect which may meet the stringent requirements set down by Mr. Mueller, as follows:

1. The wire shall have a coefficient from 20° to 30° C which does not exceed 1 ppm.
2. As the temperature of the coil goes up above 25° C, the resistance goes down.
3. The coil must be stable over a period of time.

In 1947 Mr. Mueller designed an improved bridge along the lines of the G2 type. Among the new features may be listed:

1. Range up to 400 ohms.
2. Lowest dial has steps of 0.00001 ohm.
3. Milliammeter improved so that by taking the resistance at two values of current one can extrapolate to the resistance at zero current.
4. Commutator also reverses the ratio arms.
5. Larger knobs on the dials.
6. Twelve positions on each dial.

I. Estermann reported on another project carried out by members of the conference. During the war, some of the specialty calorimetric materials were ordered in bulk, and resold to participating laboratories on a nonprofit basis. For example, some twelve or fifteen participants made up an order of some $2500 worth of monel and inconel tubing. If ordered individually, it would have cost at least twice this figure. In some cases, short pieces were shipped by mail from the Carnegie Institute stock, and much time was saved. In about six weeks or so, another order will be gotten together, and anyone interested should write to I. Estermann, Carnegie Institute of Technology, Pittsburgh.

Dr. Estermann emphasized the fact that in several cases errors in third law entropies have come from transitions which occur below the temperatures which can be reached by liquid nitrogen. Hence, extrapolation from liquid nitrogen temperatures to absolute zero involves this uncertainty. Dr. Estermann also proposed a rapid search with a calorimeter of say 1 to 2% accuracy to hunt for such transitions, and to survey a number of compounds to single out those profitable for further study.

Symposia on Conformal Mapping and the Monte Carlo Method[1]

J. H. Curtiss and E. F. Beckenbach

National Bureau of Standards, Washington, D. C.

Symposia on the Construction and Applications of Conformal Maps and on the Monte Carlo Method were held in Los Angeles at the Institute for Numerical Analysis of the National Bureau of Standards at the end of June. Between these two symposia, a two-day condensed course in automatic computation was given under the direction of Harry D. Huskey, head of the Machine Development Unit of the institute. The symposia and the condensed course formed an integrated series of lectures and discussions on topics pertinent to the work of the institute, which lasted for some ten days—from June 22 to July 1 inclusive. The combined registration for all the events, as recorded at the institute, totaled about 350 persons. The meetings were held in various buildings on the campus of the University of California at Los Angeles, where the Institute for Numerical Analysis is located.

The purposes of the Symposium on the Construction and Applications of Conformal Maps were to consider physical applications of conformal maps and their generalizations, and to study the construction of conformal maps with a view to determining the possible applicability of high speed electronic digital computing machines in this field. The symposium began on June 22 with a one-day course on programing for automatic computers given by the staff of the bureau's National Applied Mathematics Laboratories (of which the institute is one unit). This course was designed to acquaint those attending the later meetings of the symposium with the preparation of problems for automatic digital computing machines, and was especially arranged to appeal to mature mathematical analysts and applied mathematicians.

The morning of the second day was devoted to a general mathematical introduction in the form of addresses by Richard von Mises, of the Graduate School of Engineering of Harvard University, and Richard Courant, director of the Institute for Mathematics and Mechanics of New York University. J. H. Curtiss, of the National Bureau of Standards, was chairman of this meeting. Dr. von Mises gave a critical review of digital methods now available for constructing conformal maps. He strongly stressed one point which was of considerable interest to the persons in the audience concerned with machine development: In his opinion what is now really needed more than anything else in the field of high speed automatic computation is a machine which will solve very large systems of linear algebraic equations. He suggested in this connection that the speed of a proposed digital computing system should be measured in terms of the number of algebraic equations it can solve in a given length of time, rather than by its speed of multiplication. Dr. Courant's lecture was devoted to the conformal mapping of multiply connected regions, particularly as illustrated by flow patterns, and he touched upon the use of various analogue devices such as electrolytic tanks to calculate such maps.

The afternoon session, with D. V. Widder, of Harvard University, as chairman, was devoted to papers on physical and industrial applications of conformal mapping by G. Szegö, H. Poritsky, G. Stein, Ernst Weber, and I. S. Sokolnikoff. J. L. Barnes, of the University of California, Los Angeles, and North American Aviation, Inc., was chairman of the next morning session, which was concerned with fluid dynamics. Speakers were Alexander Weinstein, I. E. Garrick, Alexander Ostrowski, S. E. Warschawski, Andrew Vazsonyi, and E. P. Cooper.

Discussions of the theory of conformal maps occupied the next afternoon session. W. T. Martin, of Massachusetts Institute of Technology, was chairman and papers were presented by A. C. Schaeffer, D. C. Spencer, Stefan Bergman, Menahem Schiffer, Zeev Nehari, and P. R. Garabedian.

The general morning session with which the last day of the conformal mapping symposium opened was presided over by J. W. Green, of the University of California, Los Angeles. Papers were contributed by L. V. Ahlfors, L. Bers, P. C. Rosenbloom, G. Szegö, R. Isaacs, and M. Shiffman.

H. F. Bohnenblust, of California Institute of Technology, was chairman of the final afternoon session, devoted to numerical methods and additional notes. Speakers were Sir Richard Southwell, H. D. Huskey, D. M. Young, O. Laporte, H. Lewy, and L. H. Swinford.

The symposium was arranged by a committee of the Institute for Numerical Analysis under the chairmanship of Edwin F. Beckenbach. The role played by the Office of Naval Research in the proceedings was a significant one: a considerable number of the papers (e.g. those of Pólya and Szegö, Spencer and Schaeffer, Garabedian) arose from projects sponsored by ONR, and in fact the entire research group of the institute itself is also supported by ONR. Several interesting conclusions could be drawn from the symposium. In the first place, it seemed clear that there is a continuing interest in conformal mapping on the part of scientists working in the applications of mathematics, especially in electrical engineering and fluid dynamics. In the second place, it became evident that there was a need for a much more extensive catalog of conformal maps (given both analytically and in tabular form) than now exists. Finally it seemed apparent that digital techniques adaptable for automatic computing machinery are at present receiving little attention by those working in the field of conformal mapping, and extensive comparative studies of the relative usefulness of known methods and the newer probabilistic methods are now very much needed.

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[1] Proceedings of both symposia are being published by the National Bureau of Standards.

The Symposium on the Monte Carlo Method was arranged and sponsored jointly by the RAND Corporation of Santa Monica and the Institute for Numerical Analysis, with the cooperation of the Oak Ridge National Laboratory. Because the symposium dealt for the first time with an interesting branch of applied mathematics on which work hitherto has largely been carried on under a cloak of classification, the symposium attracted a considerable amount of attention, particularly from personnel of the laboratories of the Atomic Energy Commission.

The Monte Carlo Method can be described quite generally as the representation of a physical or mathematical system by a sampling operation satisfying the same probability laws as the system itself. Thus for example, the numerical integration of partial differential equations of a certain type can be accomplished by building up a large sample of trials of certain stochastic processes whose probability functions asymptotically satisfy the partial differential equations. In certain physical situations formerly represented by such equations, the physicist may prefer to place primary emphasis on the stochastic processes and the associated sampling operations, which he will then regard as new models to be used in place of the continuous models of classical applied mathematics.

The over-all plan of the Monte Carlo Symposium was evolved in conversations held by the committee on arrangements with J. von Neumann, of the Institute for Advanced Study.

An essential part of the plan was that a gallery of distinguished mathematical statisticians and experts in the analytic theory of probabilities would be present in the audience during the first two days, and that on the afternoon of the last day they would participate in a round table discussion at which the proceedings of the earlier sessions would be examined from the mathematician's and statistician's viewpoint.

After the introductory session on the morning of June 29, at which S. Ulam and J. von Neumann discussed the history of the Monte Carlo Method and outlined the areas in which it is being applied, some twelve papers covering current applications were given by the following scientists: Robert R. Wilson, B. I. Spinrad (a joint paper with G. H. Goertzel), A. S. Householder, Wendell DeMarcus (a joint paper with Lewis Nelson), Ugo Fano, Gilbert W. King, Maria Mayer, Preston Hammer, B. A. Shoor (a joint paper with Lewis Nelson, Wendell DeMarcus, and Robert L. Echols), and Herman Kahn (a joint paper with T. E. Harris). A paper by Lt. Williston Shor, U.S. N., was read by title. The sessions were under the chairmanship of J. von Neumann and Frank C. Hoyt.

A session on random digits was held on the afternoon of June 30 under the chairmanship of Jerzy Neyman, University of California. Three shorter papers were given first on the generation and testing of random digits by George W. Brown, Nicholas Metropolis, and George E. Forsythe. Dr. von Neumann then gave an interesting general discussion of the philosophy of random digits and of various possible techniques that could be used in generating them. One of the points he made was that any number used during the course of a computation in automatic digital computing machines ought to be the product of a reproducible routine, and from this point of view mathematically generated ''pseudo-random'' numbers and digits are to be preferred to random digits created by some sort of physical or mathematical ''truly random'' sampling process which takes place within the machine.

Both of the last day's sessions were under the chairmanship of John W. Tukey, of Princeton University. In the morning a mathematical session on the connection between stochastic processes and differential equations was held. William Feller first gave an informal general survey of the field. He was followed by J. L. Doob, who presented some recent results on stochastic differential equations, and then Mark Kac discussed certain results relating to the distributions of cumulative sums of random variable and differential equations. At the round table discussion in the afternoon of the last day it was emphasized that the method of sampling had long been used in the statistical field to solve difficult problems in distribution theory.

The symposium indicated that there are many interesting possibilities in the Monte Carlo method, particularly if it is used in connection with automatic digital computing machinery. The mathematicians of the Institute for Numerical Analysis concluded that the method is at present largely being employed by physicists as a rough tool of applied research to obtain results which can later be checked against experiment, and more attention now needs to be given by mathematicians to the theoretical aspects of the model considered in the light of the modern classical theory of stochastic processes. They also concluded that the use of the Monte Carlo Method as a technique for solving strictly mathematical problems, such as partial and ordinary differential equations, is in its infancy and much experimental numerical work as well as theoretical work must be done before the advantages of the method for a wide area of problems over the older deterministic methods of solution are established. The symposium also brought out once again that the modern classical analytic theory of probabilities is still a closed book to many mathematicians and physicists, and that there is urgent need for competent and well-organized exposition in the field.

International Conference on Instruments and Measurements

Edy Velander

Swedish Academy of Engineering Sciences, Stockholm

Three hundred fifty scientists and engineers from 16 different countries met September 21 at Stockholm, Sweden to take part in an international conference on instruments and measurements under the sponsorship of the Royal Swedish Academy of Engineering Sciences and the Association of Technical Physicists. Unesco was represented by an observer, R. Naidu. For four days papers were given and discussions were held in four parallel divisions: physical methods for the study of chemical structure, such as spectroscopy and X-rays; mechanical measurements; industrial control; and metrology.

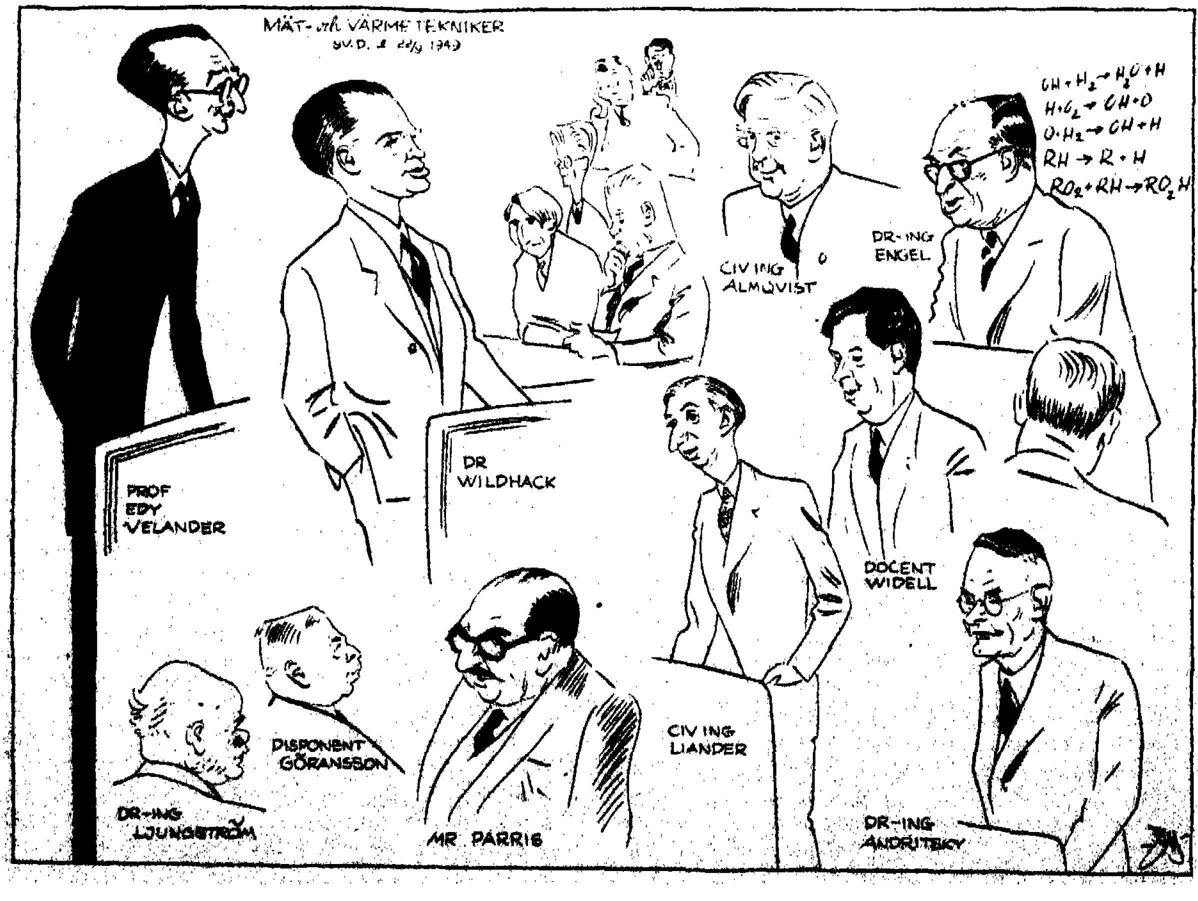
The conference was opened by Edy Velander, of the Swedish Academy of Engineering Sciences, and the opening lecture was made by W. E. Wildhack, of the U. S. National Bureau of Standards, who characterized instrumentation as the common denominator of the sciences. Instrumentation, he said, is the connecting horizontal link between the vertical divisions of science—chemistry, physics, biology, and the others. Mr. Wildhack also brought greetings from the Fourth National Instrument Conference and Exhibit in St. Louis, Missouri, sponsored by the Instrument Society of America.

In the spectroscopy division, A. C. Menzies, of Hilger and Watts, Ltd., London, talked on progress in Great Britain in infrared and Raman spectroscopy. Dr. Menzies described a new source for Raman spectroscopy which permits spectra suitable for qualitative work to be obtained with exposures measured in seconds, and spectra suitable for quantitative work in about a minute. Edy Velander

(Continued on page 383)

Photographs, 1, 3, and 5, opposite page — booths at the International Instruments and Measurement Exhibit, Stockholm (courtesy of Dagens Bild, Stockholm). Photographs 2 and 4—Raydist master recording station and continuous-wave transmitter, on display at the National Instrument Exhibit at St. Louis. Manufactured by the Hastings Instrument Company, Hampton, Virginia, for the Bureau of Ordnance, U. S. Navy, the Raydist automatically spots a vessel or any other object sending out radio waves in a given area. It measures distances up to 200 miles, unimpeded by mountains or tall buildings that intervene. Photograph 6, by Eugene Taylor, shows smoke density recorder dislpayed by the Bailey Meter Company, Cleveland, at the St. Louis Exhibit.

Sketches below, made at the Stockholm conference, are by Niles Melander.



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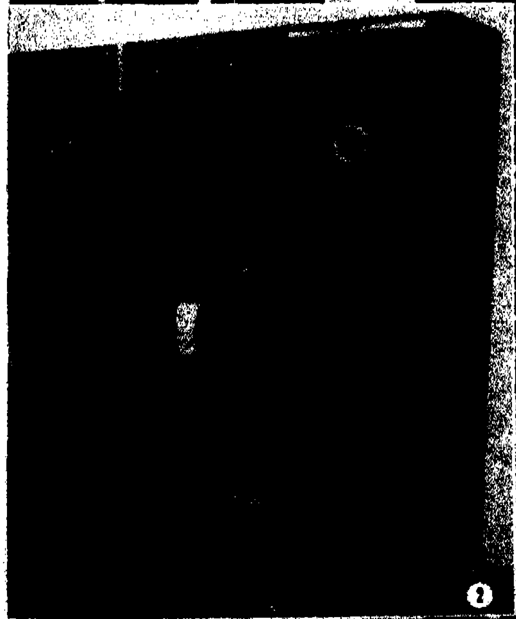

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Summaries of Selected Papers Presented at the 1949 National Instrument Conference

A Mass Spectrometer for Isotope Ratio Determinations

H. F. Wiley

Consolidated Engineering Corporation
Pasadena, California

Research workers in the fields of chemistry and biochemistry have today an attractive opportunity to use the stable isotopes of a number of common elements for tracer experiments, largely as a result of two recent developments. First, compounds enriched in the stable rare isotopes have become generally available at reasonable cost. Second, a mass spectrometer designed specifically for isotope ratio measurements now can be purchased as a complete unit.

The advantages of using stable rare isotopes for tracer experiments, as compared to using radioisotopes, are that nitrogen and oxygen have suitable stable but no suitable radioactive isotopes, and that deuterium, the stable isotope of hydrogen, may be obtained in nearly pure form. The main disadvantages are that the assay equipment is much more complex and expensive, and that the rare stable isotopes occur in nature in relatively large abundances, thus limiting their ultimate dilution when they are used as tracers. Their occurrence in nature makes possible, however, the interesting work in the field of geology reported by H. C. Urey, A. O. Nier, and others.

Following the work of J. J. Thompson, demonstrating the isotopic nature of neon, A. J. Dempster, F. W. Aston, and others designed and used mass spectrographs for the accurate determination of the masses of the isotopes of many elements. Several years ago A. O. Nier published a fairly complete description of a mass spectrometer in use at the University of Minnesota for the precise determination of the relative abundances of the stable isotopes (*1*). The basic design of this instrument has been employed in the isotope ratio mass spectrometer described here.

The fundamental principles of the mass spectrometer are illustrated in Fig. 1. The sample of gas, at an absolute pressure of about 30 mm Hg, is continuously bled through a capillary restriction into an "ion source." In the ion source, which is maintained at greatly reduced pressure, the gas molecules are bombarded by a stream of electrons emitted by a tungsten filament. The electrons have sufficient energy so that on the collision of an electron and a molecule there is a high probability that the molecule will be ionized. A certain portion of the collisions result in dissociation and the ionization of one or more fragments of the molecule. The ions are projected into the analyzer tube at high velocity by means of an electrostatic field in the source. In the analyzer tube the ions pass through the field of a 60° sector magnet, which causes the ions of different masses to follow different paths. The intensities of the accelerating and magnetic fields are adjusted to focus all ions of one particular mass on a collector, and the current to this collector is amplified and measured.

Most mass spectrometers have only a single ion collector. A comparison of the intensities of the two different ion beams requires the focusing and measuring of each beam in turn. In the isotope ratio instrument, however, there are two collectors, arranged so that all ions of one specific mass strike one collector at the same time that all ions of another specific mass strike the other collector. The currents to each of the two are amplified and the ratio of their magnitudes read directly.

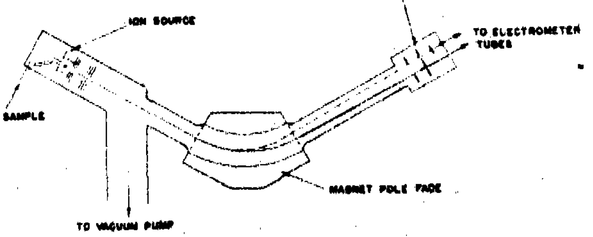

FIG. 1.

The ion source, analyzer tube, and dual collector assembly of the Consolidated-Nier isotope ratio mass spectrometer (*2*) follow closely the construction described by Nier. Except for small glass insulators, these parts are all metal, principally nichrome, inconel, and nonmagnetic stainless steel. The analyzer tube is covered by a heater winding and may be baked out at a controlled temperature to reduce background gases after exposure to the atmosphere.

A permanent magnet is used in place of the usual electromagnet and associated power supply. The magnetic field strength can be changed over a range of four to one by means of movable shunts which divert the flux from the main gap. The position of the shunts is adjusted by rotating a small hand wheel.

The high vacuum system for the analyzer tube consists of a cold trap, a water-cooled mercury diffusion pump, a ballast volume, a mechanical backing pump, and a vacuum gage. Dry ice or liquid nitrogen is used as the coolant in the trap.

The electronic circuits consist of a high voltage power supply for the ion-accelerating potentials, an electron emission regulator, and the ion current amplifiers and their power supply. The high voltage power supply provides a voltage of 2000 v, regulated to about 0.1%. The emission regulator maintains the electron ionizing current at a constant value by controlling the temperature of the tungsten filament. Two identical ion current amplifiers are used, each amplifying the current to one of the two collectors. The amplifiers employ a unity gain circuit in order to meet the severe requirements with respect to dynamic range, sensitivity, and stability. The first stage, or preamplifier, of each amplifier is mounted close to the collector assembly and its components are carefully matched to the other to reduce the drift of the amplifiers with respect to each other.

The few controls and switches are mounted within easy reach of the operator. The most important of these are the decade dials and null indicating meter used in measuring the isotope ratio.

The resolution of the isotope ratio mass spectrometer is adequate for precise ratio measurements up to about mass 70. In the case of CO_2 the contribution of mass-44 ions to the mass-45 ion beam is less than 0.04% of the mass-44 ion beam intensity.

The dual collectors cannot be used for the simultaneous collection of hydrogen and deuterium ions because of the greater spatial separation of the two ion beams at the points of focus. Provision is made, however, for conveniently comparing their intensities by using a reference voltage as a standard.

TABLE 1

REPRODUCIBILITY OF SUCCESSIVE ISOTOPE-RATIO DETERMINATIONS

Reading No.	N_2 $\frac{\text{Mass 29}}{\text{Mass 28}}$	CO_2 $\frac{\text{Mass 45}}{\text{Mass 44}}$	H_2 $\frac{\text{Mass 3}}{\text{Mass 2}}$
1	.007569	.011596	.000395
2	.007563	.011598	.000393
3	.007570	.011594	.000396
4	.007564	.011599	.000398
5	.007567	.011593	.000395
6	.007564	.011594	.000397
7	.007565	.011596	.000396
8	.007567	.011597	.000399
Mean	.007566	.011594	.000396
S. D.	.0000025	.000003	.000002

Only gas samples can be introduced into the instrument, so the products of an experiment must be converted to CO_2, N_2, O_2, or H_2-D_2, depending on the tracer used. The sample is bled into the evacuated introduction system from a suitable container through a system of stopcocks, and a Toeppler pump is provided for adjusting the sample pressure. Gas samples as small as 0.1 ml S.T.P. can be handled. To achieve maximum precision all related samples are compared to a standard sample, and this standard is run frequently in order to overcome the effects of long term drifts. The excess of rare isotope is computed with reference to the standard.

It is of great practical interest to know the maximum dilution which an enriched material can undergo and still be detected. This ultimate dilution can be computed from the enrichment of the tracer material and the minimum detectable excess of the rare isotope over its natural abundance in the dilutant. While the minimum detectable excess may be affected by natural variations of the normal material, it is the precision in measuring a change of isotope ratio at the normal abundance level which is considered here. With the mass spectrometer described, the ratio is read to six figures and is significant to about .000005, as illustrated in Table 1. Each column of this table represents eight successive measurements made within a short period of time on a single sample of the gas indicated.

With precision comparable to that shown in Table 1, 30 atom % enriched hydrogen, nitrogen, or carbon may be diluted to 1 part in 100,000 in normal material. For the great majority of applications, this precision is highly satisfactory; thus the isotope ratio mass spectrometer is a tool of outstanding value in the numerous scientific investigations involving stable isotopes.

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The Photographic Plate as an Instrument in Nuclear Research Autoradiography and Radiation Monitoring

J. H. Webb

Eastman Kodak Company, Rochester, New York

The photographic plate has become in recent years a very valuable tool for measurement of radiation from radioactive materials. Such radiations include charged particles of all types—electrons, protons, alpha particles, and ionized atoms, as well as electromagnetic radiation such as X-rays and gamma rays. Extensive applications of the photographic plate have been made in the fields of nuclear physics, autoradiography, and in radiation monitoring.

Nuclear physics. In 1945, following the tremendous expansion in nuclear physics during the war period, and the development of higher energy accelerators, physicists began to look seriously to the photographic plate as a means of registering the paths of high energy charged particles. For this purpose, the photographic plate resembles closely in action that of the Wilson cloud chamber. However, the silver bromide emulsion with its high stopping power (about 2,000 that of air), continuous sensitivity, and simplicity, gives it distinct advantages not possessed by the cloud chamber.

The Ilford Company in England pioneered in the field of producing the modern type nuclear emulsion and in 1945 produced a series of plates that far surpassed in sensitivity plates previously made. Subsequently, the Eastman Kodak Company in America, together with their British affiliate, Kodak Limited, started a program of research which resulted in a series of plates that paralleled in quality and exceeded in sensitivity any previous plates. Plates are now commercially available that will record any type of charged particle, including electrons at the minimum ionization energy, with clear tracks, and low background fog.

Nuclear track plates differ markedly from the ordinary optical type emulsions, being distinguished by a high silver bromide-to-gelatin ratio, by extremely small and uniform grain size, and very great thickness. Whereas the optical type emulsion has a silver bromide-to-gelatin ratio of about 50: 50 and a thickness of 10 μ, the nuclear track emulsion has a silver bromide-to-gelatin ratio of 80: 20 and a thickness between 25 and 300 μ.

A charged particle on passage through a material medium loses energy at a definite rate per unit of distance, depending upon its charge and velocity and upon the number of electrons per cm^3 of the stopping material. The main portion of this energy loss goes into production of ions through the interaction of the particles with the electrons of the stopping atoms. The energy loss varies directly with the square of the charge on the particle and inversely as the square of its velocity. However, at velocities approaching that of light, the inverse v^2 relationship becomes constant and relativistic effects enter to cause the energy loss curve to pass through a minimum value and rise slightly at higher energies.

Photographic action of charged particles is closely linked with the energy loss rate curve described above and the sensitivity of an emulsion can be specified in terms of the highest energy particle that can be recorded. Low velocity particles have strong photographic action and high velocity particles have weak photographic action. Plates are now available that record particles at energies corresponding to the minimum of the energy loss rate curve and will thus pick up a background from cosmic ray electrons. The useful life of such plates is limited in this way to about three weeks, there being no practical means of shielding.

The factors of range in the emulsion, grain spacing in the track, and the scattering of particles passing through the emulsion are important to the research worker doing quantitative work in nuclear track photography. By a combination of these attributes, it is possible to draw conclusions about the mass, charge, and energy of the particles under observation.

Autoradiography. A very important application of the photographic plate in recent years has been in the field of autoradiography. This consists in the technique of locating and measuring the distribution of radioactive elements by means of photographic registration of the emanations from these elements. This means has been used for years in the study of naturally radioactive constituents of minerals such as radium and thorium. Limitation of radioactive elements to the few naturally occurring ones correspondingly restricted the field of autoradiography. With the advent of atomic energy and the atomic pile, it has now become possible to produce radioactive isotopes of practically all the elements of the periodic table in considerable quantities. The use of active isotopes in conjunction with the photographic plate has placed an extremely valuable tool in the hands of the chemist, metallurgist, biologist, and petrographer, whereby chemical elements can be traced in various substances, reactions, and processes peculiar to each of these fields of work.

The technique of autoradiography consists essentially in placing a photographic emulsion in contact with a given test sample of material and registering a self-portrait of that surface by means of "tagged" tracer atoms in or near the surface. The picture may consist of a series of smoothed-over density values, as obtained in an ordinary picture, the contour map of the densities indicating the intensity of radiation. If, however, the radioactive atoms are very sparse it may become necessary to make a microscopic survey of the developed emulsion to determine the concentration of radioactive atoms from track counts. This method, though tedious, permits almost unbelievable sensitivity, it being possible to locate concentrations of the order of 10^4 atoms with isotopes having a few days' half-life. Another feature of track-autoradiography is that it permits, under favorable circumstances, the exact location of the emitting atom through location of the start of the track. Measurements have been published showing the location of active atoms within a few microns.

Radiation monitoring. Photographic plates are being used extensively now as a monitoring instrument for the detection of health hazards. A small piece of photographic film in the form of a dental packet can be worn on the person of a radiation worker and used as a continuous integrating device for measuring either particle or gamma radiation. In monitoring for radiation, it is necessary to measure X-rays and hard gamma rays, since these are very penetrating and are frequently hazardous.

The fastest X-ray emulsions will register as little as 0.05 roentgen and cover a range to about 2.0. Emulsions are available covering the range of exposures from this low limit up to 5,000 r.

The materials used in a badge usually include a high speed film covering the range 0.05 r to 2 r and a second film covering the range 1 r to 10 r. In addition, a third film may be included to monitor for neutrons. The manner of operation is as follows: A piece of Cd 1 mm thick is placed over part of the badge. The Cd will stop slow neutrons, beta particles, and soft X-rays. Therefore, the unshielded films will register beta radiation and soft X-rays. Behind the Cd shield, the films register the hard X-rays and gamma rays. The bottom film is a nuclear track emulsion that will register proton tracks. Slow neutrons can pass through the films on the side unshielded by Cd and give use to the nuclear reaction $N^{14}(n,p)C^{14}$ by interaction with the N atoms of the emulsion. The fast neutrons penetrate the Cd shield and collide with hydrogen nuclei in the emulsion to give knock-on protons. It turns out that tolerance levels of fast and slow neutrons give convenient track counts in two weeks' exposure.

Industrial Radar for Hurricane Tracking

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An explanation seems in order as to why an industrial corporation manufacturing chemicals has apparently invaded the province of the U. S. Weather Bureau in tracking tropical storms. The facts are that the program is not in competition with the Weather Bureau, but in cooperation with it; and it was undertaken in order to facilitate chemical manufacture. A hurricane need come no closer than a hundred miles to cause thousands of dollars' loss to the Dow Plants. The vulnerability of the site on the Texas Gulf Coast and the nature of some of its operations require that plant shutdown be started about twelve hours before the occurrence of hurricane winds.

A hurricane is an area disturbance consisting of circular winds about a calm center or eye. Apparently most such storms originate in the tropics, but they travel far and may strike coastal areas anywhere in the Tropical or Temperate Zones. Those in the Northern Hemisphere always rotate counterclockwise, while those in the Southern Hemisphere rotate clockwise as viewed from above. Hurricanes are usually dangerous over a diameter of 100 miles or more, with the worst winds near the center. The calm area at the center may be several miles in diameter, and barometric pressure may be as low as 27 in. In addition to the very severe circular winds, which may exceed 100 mph, the whole disturbance moves as though it were a giant top spinning and sliding at the same time. This "forward" or sliding motion, which it is sought to follow or predict, usually ranges from 4 to 15 mph. However, the storm may stay in one spot for half a day or double back on its past track.

A single storm may have a life as long as two weeks, during which it traverses thousands of miles of ocean. Once the cycle is started, energy is poured into the storm continuously in the form of warm moist air. This causes heavy rains as it spirals in toward the center and the resulting pressure drop provides impetus for continued winds and more rain. The storm usually dissipates soon after hitting land areas, but these hurricanes cause much damage and loss of life on the Gulf and Atlantic coasts. They are invariably accompanied by extremely high tides and usually by torrential rains.

The inhabitants of inland areas may have difficulty in comprehending the destruction of a hurricane, considering that the 125-mile-an-hour winds are only a fraction as great as those of a Great Plains twister. The explanation is in the large area covered and the high water. Tides of 16 ft have been experienced along the Gulf Coast, and 40-ft storm tides are not unusual in some areas. Add to this the fact that many coastal communities are 4–8 ft above sea level and it becomes apparent that cyclone cellars are of no value.

What property of a hurricane allows it to be detected by means of radar? During the war it was discovered that aircraft could hide in heavy rainstorms and avoid detection by some types of radar because the rain gave a radar indication of the same type as an airplane, but over a wide area. The indication was not changed by the *presence of an aircraft in the rain area. Later* it was found that hurricanes presented a distinct picture on these radar sets because of the rain which almost invariably accompanies them. Fig. 1 shows a typical picture of the radar presentation of a hurricane on a plan position indicator. The picture is equivalent to a map or plan view of the area with the radar located at the convergence of the radial lines. These lines and the range circles form a polar coordinate reference system used to locate targets accurately with respect to the radar.

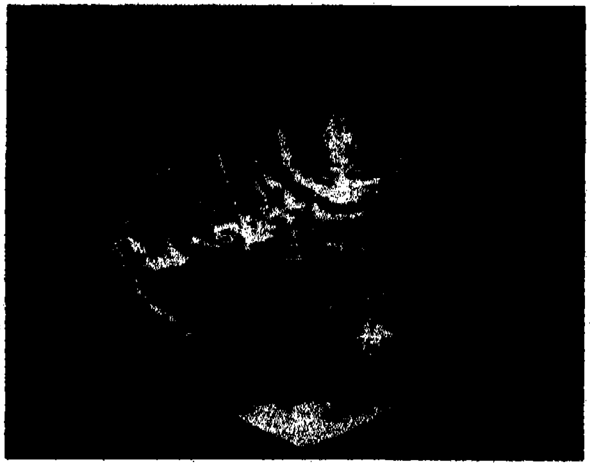

FIG. 1.

The irregular white areas represent radar reflections fom the bands of heavy rains. Radar returns of this type have been found to result from hurricanes in all parts of the world, and have never been observed from any other cause. The picture shown was made from the 'scope of a 10-cm Army radar during the 1945 hurricane which went up the Florida peninsula.

The timing device of a pulsed radar set controls the entire set—transmitter, receiver, and the presentation device. Powerful pulses of radio energy are generated by the transmitter and radiated in a highly directional beam. The receiver antenna and the receiver pick up the returned echo (if any) and send the notice of arrival to the presentation device, which measures the time required for the signal to echo from any target and gives a visual indication of this time. Usually the size and intensity of the echo and its azimuth bearing from the radar are also shown.

A single such pulse will give an indication of all the echo-producing objects in the path of the radio beam. However, since it may be desired to sweep the antenna rapidly through the complete 360° of rotation and scan the complete area covered by the radar, provisions must be made to send out rapidly recurring pulses. Thus the timer is designed to wait only the minimum time required for the reception of an echo from the maximum expected range before repeating the cycle. In the event the antenna is not rotated, recurring echo pulses are indicated in the same position on the indicator and are integrated by the persistence of the phosphor on the cathode ray tube to give a more distinct indication.

Practical radar sets usually have numerous additional blocks which perform auxiliary functions. Most sets have only one antenna, which functions alternately for the transmitter and the receiver through the use of an automatic switch. Power servo systems permit the operator to point the antenna in any desired direction by fingertip controls. Other devices may provide the automatic frequency control.

Radar for general use or search usually is equipped with a type of presentation known as the Plan Position Indicator, or PPI. In this unit, time is measured by the radial distance which a spot moves from the center of the cathode ray tube. Direction in which the spot moves is made to coincide with the direction in which the antenna is pointing. The spot starts from the center at the time the radio wave is sent out, and moves from the center outward at constant speed. Reception of an echo is made to brighten the spot momentarily. Since travel time is proportional to the distance to the echo-producing object, and time also is proportional to the radial distance the spot has moved on the indicator, this gives a bright spot for each echo-producing object in its map or plan aspect with reference to the radar set. Distance and angles may be scaled directly on this presentation.

The factors affecting radio propagation and the question of what causes a radio reflection or echo have been studied in great detail in connection with the wartime radar program. In general, any conductor of electricity or any insulator with properties greatly different from the atmosphere may cause a radio reflection. The reflection is usually diffuse, comparable to light reflected from a rough surface. To produce a strong echo, the object must be of a size comparable to or larger than a half wavelength of the radio wave. However, much smaller objects, such as drops of water, cause some reflection; and if there are enough of these objects in a given area, an echo will be received. Calculations show that the energy returned from a drop of water varies as the sixth power of the ratio of drop diameter to wavelength (*2*)

Practically, this means that 3000-megacycle or 10-cm radar sets will ''see'' rain, while 100- or 500-megacycle sets will not. Radar operating on 10,000 megacycles or 3 cm will indicate the presence of light rain or fog. Water drops of a minimum diameter of about 1.2 mm are indicated by 10-cm radar. Another point which should be emphasized is that an object need not be opaque to radio waves in order to produce an echo. An object may produce a radio echo and still transmit a large percentage of the signal. At times as many as three rainstorms in a row radially from a radar have been seen on the radar 'scope.

Radio energy of wavelengths commonly used in radar work travels essentially in straight lines, just as light does, and diminishes as the square of the distance from the source. Under normal atmospheric conditions there is a slight bending in the vertical plane which extends the radar horizon slightly beyond the optical horizon. To be ''seen'' by a radar set with its antenna at 25-ft elevations, an object at a range of 100 miles must have an elevation of about 4,000 ft, while at 300 miles an object must be about 40,000 ft high.[1] Thus, it is seen that there is a definite limit to the range that may be attained, even though a very large amount of power is used. Meterologists are in general agreement that the central core of a hurricane may rise to 50,000 ft but the maximum height at which water drops are present is probably somewhat less. Because of these considerations, it appears that no radar of present design located on the ground will be able to detect a hurricane at ranges much in excess of 300 miles. Occasionally radar targets are detected at ranges far beyond the optical horizon. This is caused by anomalous atmospheric conditions, creating a duct or layer through which radio waves are led around the earth's curvature. Unfortunately this phenomenon cannot be relied upon to extend radar coverage.

When it was decided to install a radar set for the purpose of tracking storms, the question of the most suitable type arose. The Weather Bureau recommended the SCR-584 or 784, since these sets are designed for about 3000 megacycles (10 cm) and have adequate power. A trailer-mounted SCR-784 was purchased and certain necessary modifications were made with the assistance of Weather Bureau personnel. The installation was made under terms of an agreement whereby all data obtained with the radar would be sent directly to the Weather Bureau and would be released to the public only through that agency. The set was located about two miles from the open Gulf on land about 18 ft above sea level, with a clear view seaward.

The SCR-784 has a very short pulse width or length of time during which energy is transmitted, and relatively short design range. This does not imply a lack of power, but rather a short listening period between transmitted pulses. The peak power of the set during the 0.8-microsecond transmitted pulse is 250 kw, or five times that of the most powerful commercial broadcast station. Modification of the set for the weather work began with a slowing of the pulse repetition frequency to give more listening time between transmitted pulses. Additional multivibrator stages were added to the timing circuits to give a frequency of 188 pulses per sec, which permits reception of echoes from objects 300 miles distant. Then the presentation unit was modified to cause the cathode ray spot to sweep more slowly, corresponding to the time required to receive echoes from the longer range. Multiple ranges of 100, 200, and 300 miles were provided, with a selector switch to choose among them.

This completed the necessary modifications, but several others were made in the interest of improved efficiency. A larger parabolic antenna reflector was installed in order to focus the radio waves into a sharper beam and thus give a higher concentration of energy and improved ability to resolve contiguous targets into separate pictures rather than merging them into a solid pattern.

The slowing of the pulse repetition frequency previ-

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[1] $R = 1.43\ (\sqrt{H_1} + \sqrt{H_2})$ Where R is range in miles and H_1 and H_2 are heights of radar and target in feet.

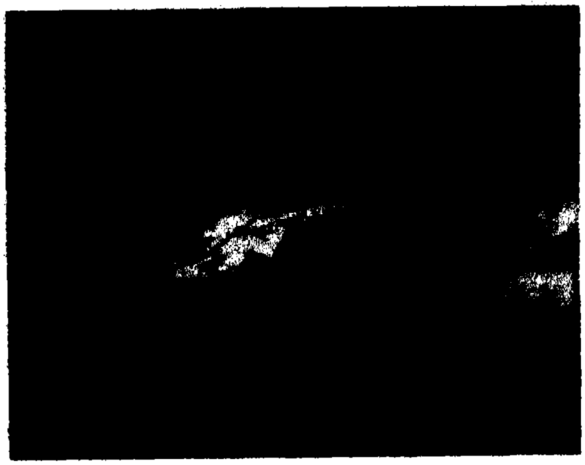

FIG. 2.

ously mentioned resulted in a reduction in the average energy transmitted by the station, since each pulse contains a definite energy and the number per second was reduced. In order to increase this average energy output, the pulse width was increased from the original 0.8 microsecond to 1.6 microsecond. In general, average power is unimportant so long as peak power is maintained, but a pulse of longer duration improves the signal from a diffuse object or one with depth, such as a rainstorm. This greater pulse width gives poorer resolution in range, but it is still more than adequate. The angular resolution of the modified equipment is of the order of two degrees, which means that at a range of 100 miles isolated objects less than four miles apart will have their echoes merged. This difference between angular and range resolution causes point targets to produce elongated pictures with the long axis tangent to range circles.

Other modifications included installation of a new preamplifier and a larger PPI tube. Camera equipment was arranged to permit rapid photographing of the screen with convenient means for identifying each picture as to date and hour. An automatic camera was also provided, to take a picture every minute. When projected as a movie film, the record of this camera should be very interesting.

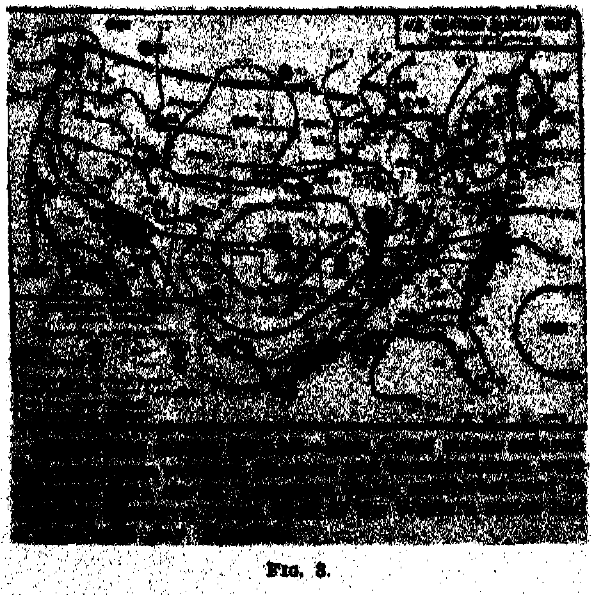

FIG. 3.

After the equipment was installed and modified, many observations were made to test the range and accuracy. Thunderstorms and isolated rains were observed and telephone calls were placed to verify the actual weather at the points where rain was indicated. Agreement was surprisingly good. Some cases of disagreement were apparently caused by rain in the upper atmosphere which evaporated before striking the ground. Results were consistent enough to show that rain will always be indicated. Many storms have been observed at ranges greater than 200 miles, at least one at 240 miles being verified. Echoes from 280 miles have been observed. Several times the radar screen has presented a picture of a line squall that agreed very closely with a front indicated on the official weather maps. Figs. 2 and 3 indicate one case of this type. Geographical features were dubbed in to orient the 'scope photograph better. This picture also illustrates a case of the radio waves' penetrating 80 miles of solid rain and still retaining power to produce an echo from rain 100 miles distant.

A program was set up for daily observations during the hurricane season—from the middle of June to the first of November. In the event that a tropical storm is known to be approaching, the equipment is manned continuously. A weather consultant is on hand to interpret the results and direct the experimental program. Experience during the war indicates that considerable information about a hurricane may be revealed by one observation on the radar screen. The center or eye of the storm is usually well defined as a clear area completely or partially surrounded by heavy rain. Even before the main part of the storm comes within range, the squall line associated with it may provide some information. These squalls may be from 40 to 100 miles from the center and they are thought to run at right angles to the line of progress of the storm. It is also generally acknowledged that rains are heaviest in the right front quadrant of the moving storm—this is based on storms in the Northern Hemisphere, which always have counterclockwise rotation as viewed from above. In a storm moving radially, that is, approaching the radar, the movement should be apparent from observations taken 15 min apart. This contemplates a speed of four mph and a range resolution of the radar of one mile.

As an experimental program, efforts will be made to obtain a vertical profile of the hurricane core by taking successive photographs as the angle of antenna elevation is increased. If this is successful at all, it will probably be at rather short ranges, since the angular resolution is hardly adequate for this.

Fortunately, the hurricane data obtained thus far with this equipment has been of a negative nature. That is, the first hurricane season and a portion of the second have elapsed with no hurricanes having presented themselves for observation. This does not dampen enthusiasm for the program in any way, the range and reliability of the equipment having been proved on rainstorms. It must be acknowledged that the hurricane which struck New Orleans on September 3, 1948, passed within 300 miles of the radar. No indication of a hurricane or even of rain was obtained during its course. However, this particular disturbance barely qualified as a hurricane, the highest wind velocity being 70 mph. Undoubtedly it did not reach the altitude required for radar observation at this extreme range.

Cosmic Ray Instrumentation

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Cosmic ray work is a subject rich in examples of advances in instrumentation leading to great discoveries in pure science. *Cosmic ray research started, in fact, as* instrument research, as the investigation of the leakage of electricity through the air in electrometers. Coulomb (1785) can be considered its founder. His career exemplifies the mutually beneficial interaction between basic research and instrument development. He first determined the law of torsional elasticity, the way in which the elastic constant depends on the radius and length of the cylinder. He then used this knowledge in the construction of a torsion balance of unheard of sensitivity. With this instrument, which could measure forces down to 0.005 dynes, he discovered the inverse-square law of force between electric charges. He then made a more sensitive torsion balance, readable to 0.001 dyne, with which he was able to prove, long before Faraday's ice pail, that there is no electricity on the inner surface of a conductor in equilibrium. Like everyone who has experimented with static electricity, Coulomb observed the apparently inexorable leakage of charge. He, however, studied it quantitatively, and resolved it into leakage along the supports and a leakage through the air. He planned *a careful study of the dependence* of the rate of leakage on the nature of the gas, its density, and its humidity, but had to postpone the project for lack of "instruments to measure exactly the purity of each gas and its humidity." Had Coulomb carried out this program, he would have been well into the physics of ionization chambers.

More than a hundred years later, in 1900, it was found that the conductivity of the air is due to continual ionization, and C. T. R. Wilson, in 1901, published the bold speculation that this ionization is due at least partly to an extremely penetrating radiation from outside the earth. In 1912-13, Hess and Kolhoerster obtained convincing evidence that there is an ionizing radiation coming down from on high, and by 1926 the scientific world was on the whole convinced of the existence of cosmic rays.

An outstanding example of an ionization chamber now in use for the continuous recording of cosmic ray intensity is the so-called Carnegie Model C, designed by Compton, Wollan, and Bennett in 1934. In this instrument the cosmic ray ionization in a 19.3-l sphere of purified argon compressed to 50 atmospheres is balanced against the ionization in a small chamber due to the beta rays from a uranium source of adjustable position. The collecting electrode, common to the large chamber, whose wall is at +250 v, and to the balancing chamber, whose other electrode is at −250 v, is connected to a Lindemann electrometer, the position of whose needle is recorded photographically through a microscope. The use of balancing makes the readings largely independent of voltage and temperature variations. With its 10.7-cm lead shield around it, this instrument has an average cosmic ray current at sea level of about 2×10^{-16} amperes, corresponding to about 15 fast particles per sec. About *once a day there is a* "burst," corresponding to the simultaneous passage of more than 500 fast particles.

An extremely useful wartime development in ionization chamber technique is the use of electron collection coupled with fast amplifiers. The leaders in the application of this technique to cosmic ray problems have been Rossi, Bridge, and Williams, who have thereby made important advances in our knowledge of high energy nuclear interactions. It is possible to rid argon of electronegative impurities, so that the electrons formed in the ionization process are collected free rather than attached. Their drift velocity in the direction of the applied field is on the order of 1000 times greater than those of the massive ions. Under appropriate conditions of field geometry and gas filling, a fraction of the total pulse height exceeding 90% is attained in a few microseconds. This makes possible the use of ion chambers in relatively fast coincidence with other chambers and counter tubes. Furthermore, the same workers, together with Hazen, have shown how the shape of the ionization pulse, as photographed on a fast cathode ray oscillograph sweep, gives information on the initial spatial distribution of ions, so making it possible to distinguish between bursts due to many fast particles spread through the chamber and bursts due to "stars" of a few heavily ionizing particles.

The ionization chamber is merely the most venerable of the many instruments now used in cosmic ray research, each of which has been responsible for tremendous advances. The instruments of cosmic ray research are the instruments of nuclear physics, just as, for example, the instruments of conventional astronomy are those of optics.

The most striking feature of cosmic ray nuclear physics is the low intensities with which one has to deal. In the Carnegie Model C ionization chamber that I mentioned the flux of penetrating particles through a sphere 33.2 cm in diam is only about 15 per sec at sea level in high latitudes. The increases in intensity at very high altitude do not exceed several hundred times; it is sometimes necessary, on the other hand, to go below ground or water, where the intensities are decreased by similar factors. A second feature of cosmic rays is their heterogeneity in composition, energy, and direction. This means that as a rule the more clean-cut in design an experiment is, the longer will it take to obtain statistically significant data. A third peculiarity of cosmic rays is their relative constancy, a feature which atones to some extent for the first two by making it possible to extend the experiments in time. Thus, in cosmic ray work one needs detectors of large size that function reliably over long periods of time. It is desirable, therefore, in a counter experiment to measure concurrently all the rates that one needs to know in order to decide whether the data are reliable. Thus the amount of apparatus devoted to monitoring often exceeds in bulk the apparatus needed for measuring the counting rate with which the experiment is concerned. In this pioneering branch of nuclear physics, one is out alone on the frontier; there is little established knowledge to go by, and one must take infinite pains to be sure that an effect one finds is not due to some equipment failure in the middle of the night or to an erratic behavior which might fail to show itself during an occasional test. It is particularly useful in this regard to record all counts on the moving strip of an operation recorder.

Certainly one of the most fruitful recent developments in cosmic ray instrumentation has been the application of electronic techniques to the sorting out of pulses, as regards time of occurrence and amplitude. The physicist now has at his disposal a potent arsenal of basic circuits for this purpose. Many of these circuits were developed before the war, but it took contact with the radar and atomic bomb projects to bring home to American physicists the possibilities of large scale application of electronic circuitry.

Dynamic Accuracy in Temperature Measurement

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The dynamic accuracy of a measuring instrument is concerned with its behavior under changing or dynamic conditions; likewise, its static accuracy is concerned with its performance under static conditions. Since it is relatively easy to define the static test conditions and to reproduce them whenever necessary, the usual accuracy specifications are limited to the static accuracy.

All practical temperature-measuring elements are imperfect dynamically simply because some heat is required to change their temperature and there is only a finite surface area through which the heat can flow. Consider a temperature-measuring element or bulb having a heat capacity of 0.004 Btu per °F and a surface area of 0.024 sq ft. If this element be immersed in a fluid flowing at such a velocity past the surface that the coefficient of heat transfer is 50 Btu/hr/°F/ft^2, the dynamic characteristics may be established. If the temperature is increasing at a rate of 20° F per min, the amount of heat flowing into the element is:

$$q = (20)(60)(0.004) = 4.8 \text{ Btu/hr.}$$

All of this heat must flow through the fluid film surrounding the bulb and, since the rate of heat flow is constant for a given rate of temperature change, the temperature drop over the film may be calculated from the steady state heat transfer equation

$$q = h\,A\,\Delta T$$

$$\Delta T = \frac{q}{hA} = \frac{4.8}{(50)(0.024)} = 4^\circ \text{ F.}$$

Thus, in order to keep the element temperature rising at a rate of 20° F per min, the fluid temperature must remain 4° F higher. In this example, the dynamic error of measurement is 4° F. Similarly, an 8° F drop would be required to cause the element to change twice as fast, or 40° F per min. The dynamic error then varies with the rate of temperature change of the thermal element, so it is generally more convenient to express the dynamic characteristics of a given element in a given medium as the ratio of the dynamic error to the rate of temperature change. This ratio Z has the dimensions of time and is called the "dynamic lag."

$$Z = \frac{(\text{dynamic error})}{(\text{rate of change})} = \frac{4}{20} = \frac{8}{40} = 0.2 \text{ min.}$$

When defined in this way the dynamic lag is in fact the time by which the thermometer reading lags the true temperature when both are changing at a constant rate.

Reduction of dynamic error. In terms of the bulb heat capacity, C, its area A, and the heat transfer coefficient h, the dynamic lag is

$$Z = \frac{C}{Ah}.$$

This equation indicates some of the possibilities for reducing the dynamic lag and thus improving the dynamic accuracy. Any increase in the coefficient of heat transfer produces a corresponding decrease in Z. This means that the bulb should be located at a point where the fluid velocity is high, since h increases approximately as the square root of the velocity. By the same token, the coefficient of heat transfer is much greater in agitated liquids than in gases or even vapors at low velocity, so if a choice exists the better medium should surround the bulb.

Another possibility of reducing the lag is to change the thermal element to reduce its heat capacity or increase its area, that is, reduce the value of C/A. The most common method is to reduce the diameter of the element. Occasionally, finned bulbs are used, although the improvement that can be obtained is limited. In general, for bare bulbs or thermocouples, without a protecting well, the internal thermal resistances are negligible compared to the fluid film resistance and the element can be considered as homogeneous and characterized by a single heat capacity and a single thermal resistance as was done in the previous example. Actually, there are small thermal resistances throughout the element which add a fraction of a second to the lag caused by the fluid film, but the latter are much larger, varying from a second or two up to several minutes. This is not the case for thermal elements installed in protective wells, unless exceptionally good thermal contact exists between the sensitive element and the well, since an air space of a few ten-thousandths of an inch between the two can add many seconds to the dynamic lag. In addition, a more complex "two capacity" lag results which will not be considered in this paper.

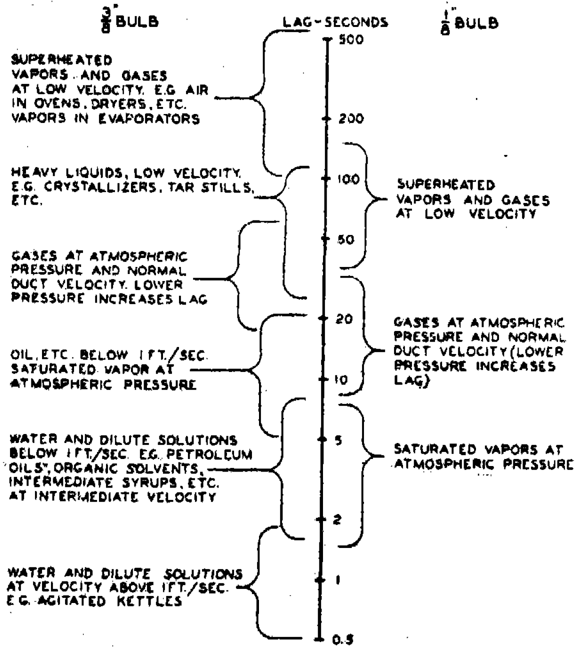

FIG. 1. Normal thermal lags.

Even with good installation practice and the use of bulbs with low C/A values, the lag is often larger than can be tolerated and measurement of transient changes cannot be made with any accuracy or control results are miserable. In Fig. 1, approximate values of normal bulb lags are given for a variety of conditions for bulbs ⅜ in. and ⅛ in. in diam. These values are not limited to liquid- and gas-filled thermal systems; they apply equally well to a bare thermocouple ⅛ in. in diameter or to a thermocouple welded into a ⅜-in. tube, since the C/A values will be essentially the same.

This table shows that bulb lags are often quite large. One should also remember that the possibility of using small-diameter bulbs is generally limited to noncorrosive and nonerosive gases and vapors; furthermore, a ⅛-in.-diam bulb is often too frail to stand the mechanical forces encountered in flowing streams of viscous liquids.

Derivative compensation for dynamic lag. In view of the rather obvious requirements for faster speed of response, it seems desirable to point out another way of improving the dynamic accuracy of thermal systems.

As in most compensation problems, the method is quite simple. A quantity proportional to the error is measured and the appropriate correction is applied to the instrument reading. In this case, the error is the temperature difference between the sensitive element and the temperature of the medium:

$$\Delta T = \left(\frac{dT}{dt}\right)\frac{C}{Ah} = Z\left(\frac{dT}{dt}\right).$$

Since the error is proportional to the rate of change of bulb temperature, dT/dt, one merely needs to measure this rate of change, multiply by the appropriate bulb lag and add this correction to the bulb temperature to obtain the corrected or true temperature.

The pneumatic temperature transmitter offers an easy solution to this problem. Consider the simplified circuit of a force-balance pneumatic transmitter as shown in Fig. 2. A gas-filled thermal system has its bulb immersed in the process medium and the force resulting from the gas pressure on the diaphragm is balanced by the biasing spring and the force from the balancing bellows. An increase in bulb temperature, for example, will move the baffle away from the nozzle, decreasing the nozzle back pressure and increasing the relay valve output pressure (P_0). This increase in output pressure results in a flow into the balancing bellows through the open-needle valve and applies an opposing force to the diaphragm of sufficient magnitude to substantially prevent movement of the diaphragm and baffle. The change in balancing bellows pressure P_F (and the output pressure P_0) is then directly proportional to the change in bulb pressure, which is in turn proportional to its temperature.

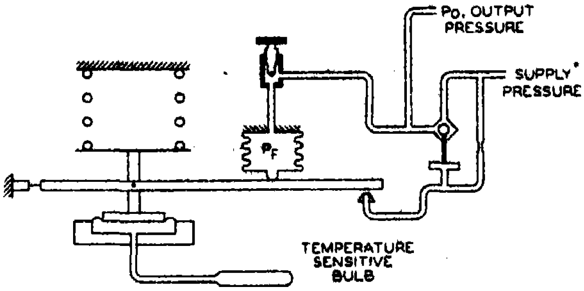

FIG. 2. A simplified schematic of a Transaire force-balance temperature transmitter.

By suitable calibration, a balancing bellows pressure change of, say, 3 to 15 psi can be made to correspond to the desired temperature span of the transmitter. The output pressure is then transmitted to a pressure receiver also having a span of 3 to 15 psi. Ambient temperature and barometric pressure compensation would, of course, be required in any complete instrument, although they are not shown.

Returning to the derivative or "dynamic compensation" for thermal lag, we note that the rate of pressure rise in the balancing bellows is directly proportional to the rate of temperature rise of the gas-filled bulb. Increasing pressure in the balancing bellows will require the flow of air into the bellows. In fact, the rate of flow is directly proportional to the rate of pressure rise in it. Introducing a capillary or needle valve restriction in the line to the balancing bellows will result in a pressure drop which is proportional to the rate of temperature rise of the bulb.

The output pressure of the relay valve will then be equal to the balancing bellows pressure plus this pressure drop. Suitable adjustment of the restriction allows selection of the appropriate lag correction factor to neutralize the dynamic error. The adjustment dial on the restriction can, in fact, be calibrated directly in terms of the time lead (or dynamic compensation factor) introduced by it.

Adjustment of the dynamic compensation factor can be made in a number of ways. Generally, the lag of the thermal element can be estimated from tables with sufficient accuracy and the dynamic compensation factor is set equal to this lag.

It is believed that the use of a derivative transmitter to achieve dynamic compensation for the inevitable lag of thermal elements offers a valuable and unique tool in the field of temperature measurement and control which makes possible a degree of speed and accuracy not previously obtained.

Velocity and Flow Measurements with an Improved Thermal Instrument

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Precise measurement of the velocity of free air currents moving at rates as low as 5 ft/min has always been a difficult problem. It is one, however, that is constantly present in a wide variety of applications such as meteorology and microclimatology research, air conditioning, heating and ventilating work, measurement of rate of flow in gas or air systems, hay and tobacco drying processes, and general process control.

A new type of electrical anemometer that has recently been developed for applications such as these allows velocities as low as 5 ft/min to be determined with accuracies previously limited to high velocity measurements. The new instrument, which is known as an Air Meter, operates by placing a heated precious-metal thermopile in the airstream. The flow of air past the thermopile tends to bring the thermopile wire, consisting of a succession of thermojunctions, to the same temperature throughout. The thermal differences between these junctions induce a thermal direct voltage proportional to the temperature differences. Thus, flow of air past the thermopile tends to reduce this temperature difference and, therefore, to reduce the direct voltage generated by the thermopile.

The thermopile, or sensitive element of the anemometer, is made up of alternate sections of thermocouple materials butt-welded to obtain a continuous wire. This wire is then heated by passing an alternating current through it. Cold junctions of the thermopile are obtained by attaching alternate junctions to copper mounting studs, thereby supplying sufficient heat conductivity away from the junctions to keep them at ambient temperature. The other junctions, not in contact with the copper studs, are heated by the alternating current. Alternate junctions therefore become the hot and cold junctions of the thermopile.

Normally, maximum voltage is obtained with zero air velocity, and zero output represents a large cooling effect by a high air velocity. However, when high accuracy is desired over a wide range of velocities, a second series of thermocouples can be arranged with opposite polarity and shielded from any air currents. With these couples arranged to buck the voltage from the velocity pickup thermopile, zero voltage output is obtained for zero air velocity and full-scale indication of the indicating or recording instrument is obtained for the particular air velocity desired. Sensitive instruments of this type are well suited to process control, the rapid response of the electric signal operating controls and giving warning of deviations.

The principle of placing a heated thermopile in an airstream for determining air velocities has many advantages over older types of anemometers. Thermal anemometers have no moving parts to introduce frictional errors, which are very important in low velocity measurement. Also, they are not affected by icing. This thermopile type anemometer has additional advantages over the usual hot-wire types in that the indicating or recording instrument consists of a measurement of direct current voltage instead of a small change in resistance. The errors introduced by lead resistance are thus much less. Errors introduced due to change in air temperature are compensated for, since both cold and hot junctions are equally affected by any change in ambient temperature. The instrument measures the temperature difference between these junctions, all of which are exposed to the airstream. Likewise, radiation effects tend to cancel.

A two-thermocouple arrangement which lends itself to an inexpensive type of construction has been incorporated into a standard low-cost model which has proven very versatile and reliable in laboratory and field use. The indicating meter is small and can easily be held in the palm of the hand while taking readings. The thermopile element is a separate probe which may be plugged directly into the indicating meter, or which may be used at the end of graduated extension wands or cables. For applications requiring extreme sensitivity and accuracy for very exacting research measurements, a larger instrument has also been developed.

Experience has proved this type of thermal anemometer to be exceptionally stable. One instrument has operated continuously for a year in the laboratory and a second instrument, designed for indication of nondirectional air flow, has operated for the same period on top of a building and has consistently indicated wind velocity without failure or zero shifts.

The Air Meter is well adapted to remote recording on standard strip-chart potentiometers or other standard types of indicating or recording instruments which operate from direct voltage. The ability of anemometers of this type to measure extremely low velocities, combined with their inherent stability, ease of operation, low power requirements, and adaptability to remote indication or recording, suggests many applications of a widely varying nature.

Light Rays Can Be Tools

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The supreme precision of a beam of light is an old story. It is straight—regardless of the distance it travels. It exerts no pressure on the objects it falls upon. It does not wear. And it is exact, furnishing the universal standard for all measurement.

But if these properties of light are themselves an old story, their applications in industry constitute a new one. For not until light has been harnessed by optics are these properties useful as a means of gaging in the shop or plant. Yet once harnessed, light rays can be tools—can, for example, measure a rise of 0.002 in. in a distance of 80 yd, measure the angle between two related surfaces to an accuracy of less than one sec of arc, or magnify an object to a degree where one operator can check 18 separate dimensions to tolerances of 0.0005 in. at a rate of 280 parts an hour—an operation that formerly required 9 operators and 16 mechanical gages.

Each of these applications applies familiar principles of light. In one case a beam of light is used as a perfectly straight line of reference. In another, this beam is put to work by applying the simple geometric principle that the angle of reflection equals the angle of incidence. In the third, advantage is taken of the ability of optics to change scale. Which property is pertinent depends on the product in manufacture, how it is made, how it is inspected, and how it is used.

This does not mean, however, that a large research program in optics is a prerequisite of using light as an industrial tool. Certain basic optical designs are applicable to the majority of industrial uses because of their universality and their versatility. These fall into three major classifications: (a) Autocollimation—in which a beam of light is reflected back on itself from a reference surface on the work, for checking the angle between two planes, however far separated, to any desired accuracy. (b) Telescopic alignment—employing such devices as double-ended telescopes and divided-aperture objectives, for establishing by absolute methods a line of sight in fixed relation to a plane and then measuring displacements of distant targets from it. (c) Projection of silhouettes and illuminated surfaces to a screen, where they can be measured and examined at any magnification—by eye, photocell, or by photography.

Instruments falling under the classification of autocollimation are for the measurement of angle. Everyone knows that to see his image in a mirror he must stand directly in front of the mirror, and this principle is the basic premise of the autocollimator. Yet these instruments are capable of working to angular tolerances of less than one sec of arc: i.e., to an angle equivalent to a rise of 0.001 in. in a distance of 17 ft.

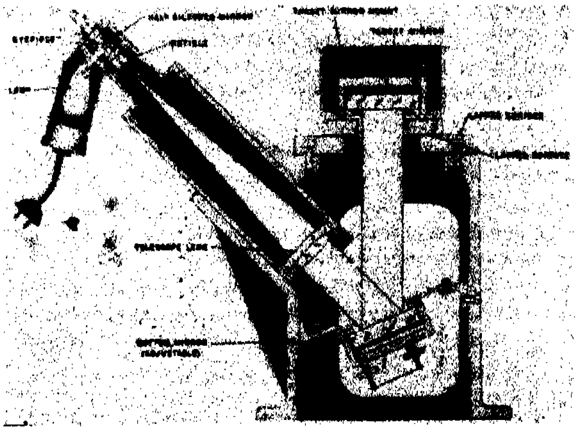

FIG. 1.

Fig. 1 is a cross-sectional view of an autocollimator and target mirror mount used to check flange faces on the ends of a tube for parallelism. The instrument is self-checking, since the reticle image will coincide exactly with the reticle itself when the surface of the mount is placed directly on the surface of the instrument. Once the instrument has been zeroed in this way, the tube may be placed on the surface of the instrument and the target mount placed on the opposite end of the tube. Any deviation from parallelism in the flange faces will be manifested by the amount the reticle image is offset from the reticle.

Modifications of this instrument may be used for checking many other types of angular measurement, or its principles may be employed in special instruments for complex tasks by combining autocollimation with other optical devices, such as telescopic aligners.

The telescopic aligner, shown schematically in Fig. 2, establishes by absolute methods a line of sight in relation to a plane and will measure displacements from this line to ten-thousandths of an inch. The target itself may be regarded as an illuminated vertical arrow which is viewed under two different conditions, as an erect and as an inverted image. The objective lens directs these images to a common focal point and when the target is on the level of the lens axis, the images coincide. Conversely, when the target is displaced from the lens axis, the images move in opposite directions. Thus the target may be used to establish a position along a line with complete accuracy and regardless of distance.

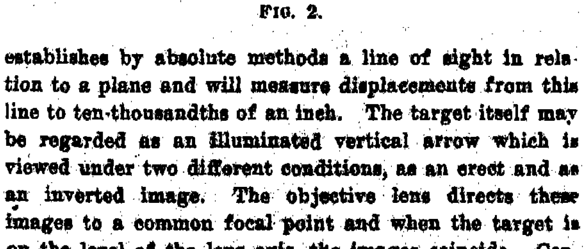

FIG. 2.

The repetitive accuracy of measurement is remarkable. Readings can be repeated to a tolerance of ±0.0003 in. with the target at a distance of 30 ft from the aligner.

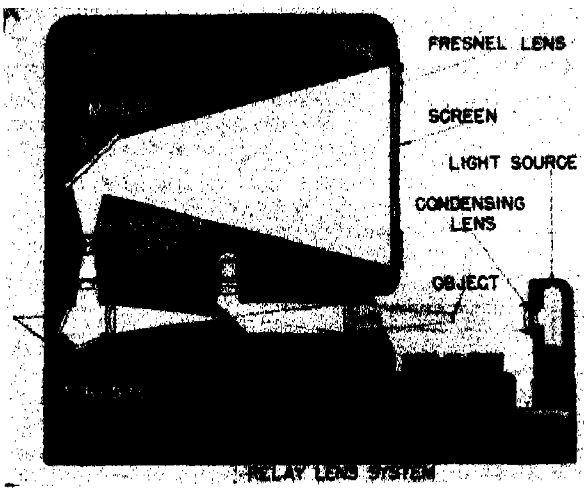

FIG. 3.

With the target at a distance of 100 ft, measurements can be made with a tolerance of ±0.003 in.

While this instrument was designed primarily for aligning planer beds, it can undoubtedly be applied to the solution of other problems involving heavy machine tools and other massive equipment.

The third major classification of optical instruments, that of contour projection, introduces the only use of optics for gaging mechanical components that has been employed to any extent in industrial inspection. However, the practically limitless applications of this tool to inspection problems have not been generally realized.

All contour projectors work on the same basic principle and are made up of a light source, object, lens, and screen. However, if this simple system is supplemented with any of several optical elements, its versatility is greatly increased. The first of these elements is a relay lens (Fig. 3) and the second a Fresnel lens, mounted behind the screen.

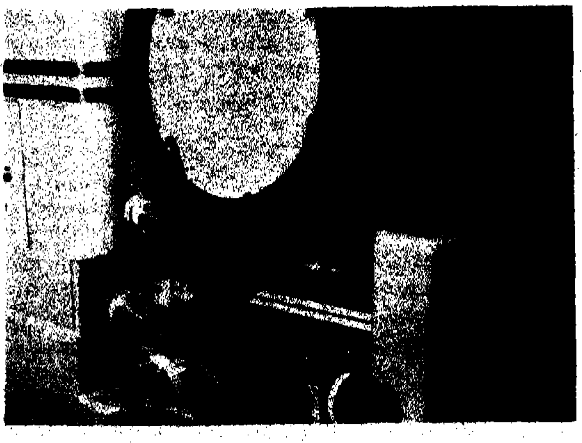

FIG. 4.

This Fresnel lens provides increased screen brightness by concentrating the cone of light coming from the screen into a cylindrical beam directed at the operator. This permits the use of the projector in lighted rooms without hoods or curtains and, with the relay lens, helps to provide surface projection of brilliance hitherto customary only in shadow projection.

There are many instances in which a work piece may be *recessed or obstructed, or measurement of surface details* must be made. In such cases the surfaces themselves can be projected as a bright image in contrast with the more familiar contour, or shadow, image. Here the relay lens affords a unique opportunity for obtaining maximum illumination. An elliptical mirror may be inserted in the relay lens system (Fig. 3) and light from a 1000-w lamp directed through the front lens to the object. The object reflects the light back in turn, but the reflected image converges and a hole in the mirror permits the image to pass through and be directed onto the screen.

So successful is this system that it is possible actually to project the surface of black Bakelite molded parts.

The relay lens also serves two other functions of major importance, both of which increase the scope and versatility of contour projection. It permits an 8-in. clearance between the work piece (Fig. 4) and the first lens of the system, at all magnifications, providing ample space for awkward parts or for efficient staging fixtures. It also transfers an image at 1:1 magnification to the rear of the instrument, where projection lenses of any desired magnification may be mounted.

Here again, the versatility of the science of optics is illustrated, incorporating in a single system elements which can do, not one, but a variety of tasks, with the inherent advantage of a precise, pressureless, and predictable gaging element.

The Differential Transformer as Applied to Instrumentation

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The measurement of substantially straight line motions is an important factor in the science of instrumentation: for example, the measurement of the displacement of a bellows or a diaphragm, the motion of a float, the tip travel of a Bourdon tube, and the tilt of a weigh beam. Various means have been devised for converting these displacements into signals suitable for electrical transmission, but only in recent years has the differential transformer been used to any extent in this field.

It is the purpose of this paper to treat with only two general phases of this topic: (1) the basic design of differential transformers: and, (2) the circuits which permit their application to the measurement of instrumentation variables such as pressure, flow, and force.

A differential transformer consists essentially of a primary coil, two secondary coils, and an armature of magnetic material. The primary coil is energized from a suitable source of alternating current, the two secondary coils are connected so that their output voltages are 180° out of phase and the armature is located so that it can alter the relative flux distribution which exists between the primary coil and the two secondary coils. (See Fig. 1.)

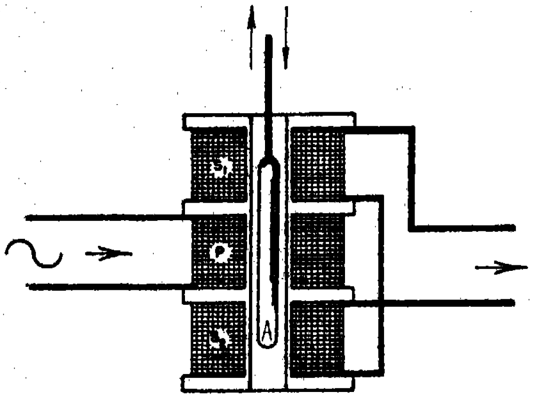

FIG. 1. Differential transformer.

Motion of the armature *A* toward secondary coil *S*1 results in an increased output of one phase and motion of *A* toward *S*2 results in an increased output of the opposite phase. If *S*1 and *S*2 are identical coils and *A* is located so that each receives an equal amount of flux, the voltages induced in these secondary coils will be equal and out of phase and a theoretical output of zero will result. This condition denotes the null, or balance point of the differential transformer.

Obviously, the electrical energy could be applied to coils *S*1 and *S*2 and the differential output obtained from coil *P* without basically altering the transformer structure or the results obtainable. This has been done in some designs.

In accordance with the previous descriptive data, the differential transformer becomes essentially a self-contained device for producing an electrical output, isolated from the source of power, which may be controlled in both amplitude and phase by an adjustment of the flux distribution within the transformer. It should never be considered as part of a bridge circuit, but only as an isolated source of controlled alternating current.

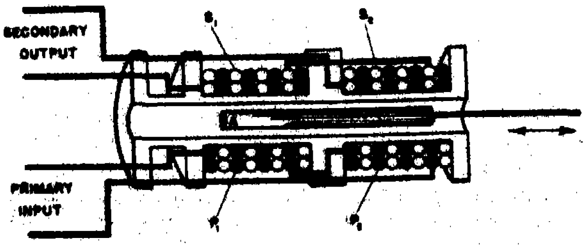

FIG. 2. "Atcotran" type of differential transformer.

Investigation over a period of years and numerous field tests have led to a design which combines the desirable features of a differential transformer into a structure which can be reproduced accurately. This device is shown in Fig. 2. The coil structure, divided into two main sections, contains four windings, two of which serve as the primary while the remaining two act as the secondary. The small section at the left end of the coil form is used to house the necessary interconnections and lead wire terminations.

A design of the type shown in Fig. 2 insures equal and stable electrostatic coupling between the primary and secondary windings and minimizes temperature drift due to changes in such coupling. Uniform magnetic coupling is also insured on this same basis and this factor makes it possible to maintain reasonable linearity without a large number of turns. This in turn means that a coil of relatively low impedance can be produced which will adequately match into standard audiofrequency transformers and allow the use of relatively long transmission lines without danger from stray pickup and phase shift due to line capacity.

A coil structure of this type is also quite versatile. Although the unit is normally used with the primary coils connected series aiding and the secondary coils connected series bucking, this condition may be completely reversed, or the primary coils may be connected parallel aiding and the secondary coils parallel bucking, etc. Also, since the unit is essentially a two-coil balanced structure, it is quite possible to bring out a center tap between the two adjacent windings and use one section as an induction bridge. There is an almost endless list of workable combinations when one considers that more than two windings can be placed in each section.

Some advantages inherent in a well-designed differential transformer are:

(1) Negligible phase shift throughout the operating range. In inductance bridge circuits the resistance of the coils remains constant while the inductance of these coils varies over a considerable range. The resulting shift in the resistance and inductance vectors causes a very substantial phase shift which must be taken into consideration in the design of any indicating circuits. In a differential transformer such as the "Atcotran,"[1] the change in inductance for an armature motion of ± 0.1 in. (twice the normal range) is entirely negligible. Therefore, servomechanisms operating with these transformers need not be compensated for phase shift throughout the indicating range.

(2) The source of power is isolated from the output circuit. This feature allows units to be combined in various ways and to perform many useful mathematical functions.

(3) A high degree of linearity and reproducibility of output with respect to armature displacement is obtainable. A linearity of better than ± 0.05% may be expected from standard production run Atcotrans, and these units will match each other within ½% without the use of calibrating resistors, or other means of compensating for normal irregularities in materials and in winding.

For comparison let us assume a single bonded type strain gage, connected into a bridge circuit and strained to approximately 0.003 in. per in. (about 100,000 psi stress in steel); it would yield an output of 0.0015 v per volt input for this range. A differential transformer over its normal maximum range of 0.800 in. would yield an output of .075 v, or an output advantage of 50: 1 on a range basis of comparison.

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[1] Trade mark registered. Automatic Temperature Control Company, Inc.

To apply the differential transformer to a measuring problem a null type of circuit is recommended. (See Fig. 3.) In this circuit the output from the transmitting unit, *T1*, is 180 degrees out of phase with that of the balancing transformer, *T2*, and the difference voltage is fed through an amplifier to one phase of a two-phase servomotor. The other phase of this motor is energized continuously from the line. When both differential transformers are producing equal, out-of-phase voltages, there will be no input to the amplifier and the motor will be at rest. However, if the armature of transformer is displaced slightly, a restoring signal will be produced which will cause the motor to rotate and return the system to balance.

The reasons for using a null balance system are:

(1) It is unaffected by line voltage changes. If there is no stray 60-cycle pickup in the system, it will be unaffected by normal line voltage changes and even an excessive pickup voltage, equal to 10% of the total signal at full scale, would only cause a 1% change in reading for a 10% change in line voltage. In normal systems the pickup voltage will always be less than 1% of the full scale signal.

(2) It is relatively unaffected by resistance changes in the connecting leads. The addition of resistance to either the primary or secondary circuit will have little effect on the balance of the circuit, although its sensitivity will be affected. This means that changes in coil resistance due to heating will not unbalance the circuit.

The following information may be of value in the application of null balance circuits:

(1) Electrical zero check. If a shunt is connected across terminals 3 and 4 of the transmitting differential transformer (See Fig. 3), its output will be zero and the servo system will come to balance at the null position of the balancing differential transformer.

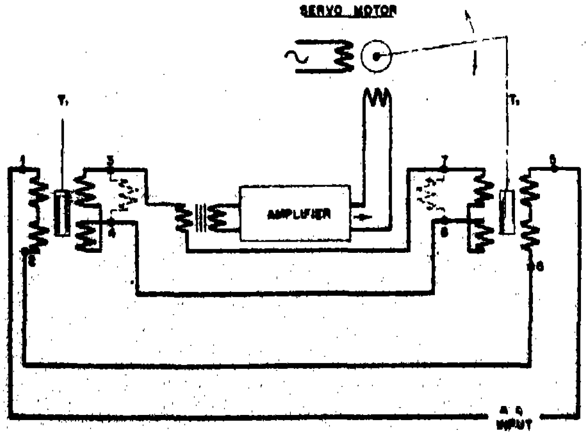

FIG. 3. Null balance circuit for differential transformers.

(2) Electrical range change (ratio control). If a resistor is connected across terminals 7 and 8 of the balancing transformer, *T2*, (See Fig. 3) its output will be reduced. When the output of *T2* has been reduced in this manner, the servomotor will now have to move farther to balance a given change in input voltage from the transmitter and the effective sensitivity of the servomechanism will have been increased. This method has been successfully used for sensitivity ratios up to 10: 1 and may also be used as a calibrating means.

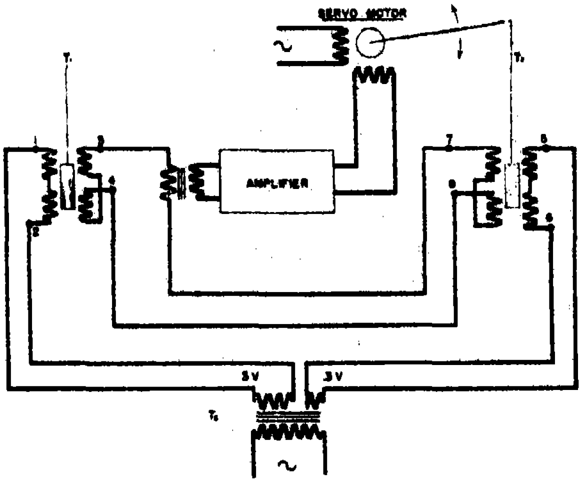

FIG. 4. Null balance circuit with transformer type range change.

It is possible to obtain similar results by means of transformers instead of by means of shunts. See Fig. 4. Here the input voltages to the two differential transformers are set up as a predetermined ratio by the supply transformer, *T3*. Ratios as high as 40 to 1 have been used with a circuit of this type, although changes in lead resistance affect the ratio to a certain extent.

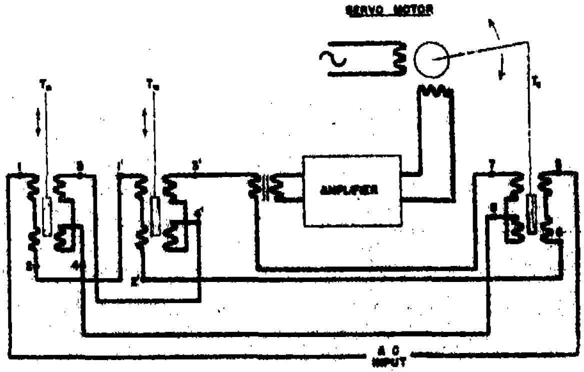

FIG. 5. Algebraic summation circuit.

(3) Algebraic summation. See Fig. 5. The use of more than one differential transformer as a transmitter is both feasible and useful. When transformers *T1a* and *T1b* are properly connected, their outputs are algebraically summated in such a way that their output voltages represent the magnitude to be measured and their phase becomes the plus and minus sign for this magnitude. The servomechanism balances out the resulting signal and indicates the algebraic sum of the two variables controlling transformers *T1a* and *T1b*. Up to six transmit-

ters have been successfully summated by this method without difficulty. A typical application is the use of four Atcotran load cells to support a weighing platform and a weighing servo to indicate the average signal from these cells. In this way the weighing platform becomes independent of load position.

(4) Multiplication. If the input of one differential transformer is used as a source of input voltage for a second differential transformer, multiplication results. Since adequate power is not available in one transformer to drive another, the use of an electronic amplifier is recommended. See Fig. 6.

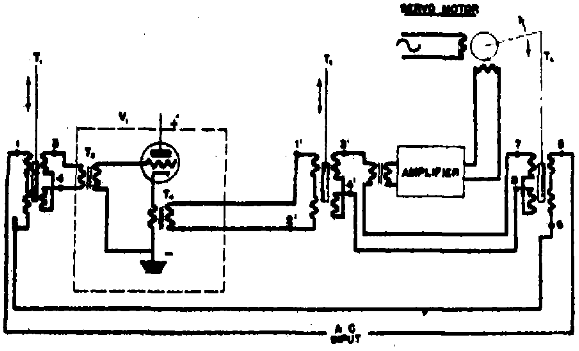

FIG. 6. Multiplying circuit.

This device has been used for compensating the output of a flow meter for changes in pressure and for other similar uses.

(5) Use of null balance circuits. In making connections between the various components of differential transformer null balance circuits, the author has standardized on the following procedures: (a) use of twisted pairs for all primary circuits; (b) use of shielded, twisted pairs for all secondary circuits, for runs over 50 feet; (c) number 20 BS gage, stranded wire is of ample size for most installations. The wires should be run in conduit but never in the same conduit with power lines.

If properly installed, transmitters and receivers may be several thousand feet apart. Special 400-cycle systems requiring only a *50 millivolt input* signal to the transmitter have been used for hazardous locations.

Although the differential transformer is still a newcomer in the instrument field, there are some standard instruments available. These include circular scale indicators with ½% of reading accuracy (above 10% of scale) and a ten-to-one sensitivity switch; multichannel optical indicators with three automatically selected scales, a scale length of 84 in. and a 2-sec speed of response; strip chart, round chart single and multipoint recorders, controllers, etc. The switching of various input circuits into one indicator, or recorder, such as is normally done with thermocouple circuits, is standard practice with most differential transformer instruments. Transmitters, for pressure, flow, density, level, motion, etc., are also available as either standard, or custom built devices.

While it is obvious that a direct indicating, meter type of instrument may be used with a differential transformer instead of a servodriven, null balance device, no time will be devoted to these units at this time. It is only with the null balance systems that the remarkable accuracy and stability of the differential transformer can be realized.

In general, differential transformer instrument systems should be used (1) whenever highly accurate measurements of motions are required, (2) where minute forces are available and friction of any kind would be a disadvantage, (3) where electrical transmission of various variables is a requisite, and (4) where it is desired to express certain mathematical functions electrically.

Summaries of Selected Papers on Instrumentation Presented at the 1949 Gordon Research Conferences

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X-Ray Powder Diffraction Analysis Film and Geiger Counter Techniques[1]

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In this note a few of the techniques and new instrumentations for X-ray powder diffraction which have been developed at this laboratory during the past six years will be briefly outlined. General descriptions of the applications of the powder method are given by Bunn (*4*), Guinier (*7*), Hanawalt, Rinn and Frevel (*9*) and Straumanis (*12*).

In the Norelco X-ray diffraction aparatus the X-ray tube is sealed off, thus eliminating vacuum problems, vertically mounted, water cooled and full-wave rectified to aid Geiger tube work. The voltage and/or current may be continuously varied. One feature of the apparatus is that four pieces of accessory apparatus, including one or two spectrometers, can be operated simultaneously.

Powder Cameras. The design and use of Debye-Scherrer powder cameras are deceptively simple. In order to ob-

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[1] Based on papers given at meetings of the American Society for X-Ray and Electron Diffraction, 1947–49.

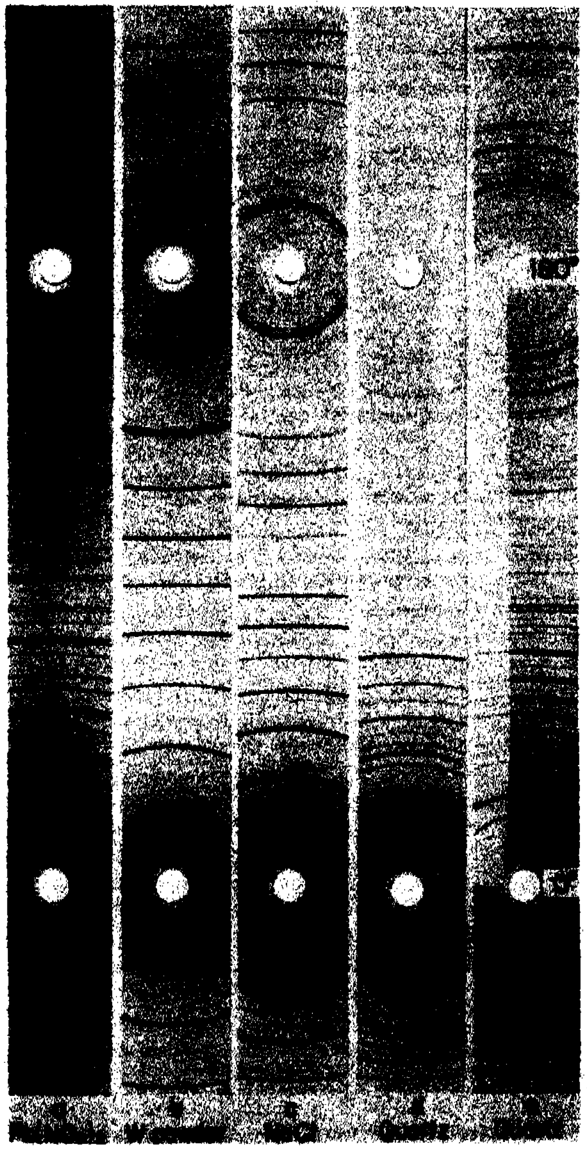

Fig. 1. X-ray powder photographs, 114.6 mm diam powder camera, Straumanis film mounting, CuK, 40 kvp, 20 ma, $\psi = 2°$. *a–d*, 0.0006-in. nickel filter, specimen mounted on 0.008-in. Lindemann glass fibre, 8 hr exposure; *e*, filter on side of film, specimen packed in Lindemann glass capillary with 0.012-in. bore, 1 hr exposure.

tain the excellent films shown in Fig. 1, certain techniques, all quite well known but not commonly practiced, are required, as much as a good camera. The mechanical design of the camera allows rapid and exact centering of the specimen and mounting of the film, exact alignment and repositioning with the X-ray tube, and easy manipulation in practice (*3*). The collimator system has been carefully computed and designed to give a minimum and almost uniform background from air scatter, no "blind" region on the film from about 5° to 175° 2θ, complete absence of scatter from metal parts of the camera or collimator, excellent line shape, and good intensity and resolution (*11*).

Precise alignment of the collimator and exit port axes with the specimen rotation axis is essential and can be tested by photographing a very thin fibre of a heavily absorbing specimen. If the alignment is accurate, the diffraction arcs will be either evenly split doublets or smooth lines of equal thickness on both sides of the 0° film hole along the equator of the film. If the collimator system is misaligned, the arc will appear as a doublet on one side of the hole and a smooth line on the other or the lines of the doublets will be unequally spaced. This can be corrected by mounting both the collimator and exit port tubes in bushings, preferably of the cone-in-cone type, whose position can be adjusted in the camera body. The adjustment is made, using a very thin glass fibre for a specimen and a magnifier fitted over the end of the exit port tube. We have found it useful to translate and rotate the specimen during exposure to obtain smoother lines and better relative intensities (*3*).

TABLE 1

Projected Sizes of 10 × 1.2 mm Focal Spot

ψ	Line focus	Spot focus
2°	0.04 × 10 mm	0.35 × 1.2 mm
3°	0.06 × 10 "	0.5 × 1.2 "
6°	0.12 × 10 "	1.0 × 1.2 "

The focal spot of the new Norelco X-ray tube is 10 × 1.2 mm and the tube is constructed to allow viewing the target at grazing incidence. If ψ, the angle between the target surface and the axis of rotation of the specimen, is decreased from the conventional 6° to 3° or less, the projected size of the focal spot becomes small enough so that it can be used as the effective source slit and an actual slit is not required (*7*). The projected sizes are shown in Table 1.

The intensity as a function of ψ reaches nearly a maximum at 2°, with practically no increase at larger angles. For a given collimator with fixed divergence aperture the divergence of the beam increases as the projected size of the focal spot increases and hence the resolution decreases. The sharpest lines with maximum *peak* intensity are thus obtained at $\psi = 2°$. The divergence of the beam is limited by a circular aperture 0.5 mm diam, which in the case of the 114.6-mm-diam camera is 14 mm in front of the specimen. The full angular aperture with this arrangement is 0.4° in the vertical plane and 0.9° in the horizontal plane along the specimen axis. Although most camera tracks are set for $\psi = 6°$, the method can be applied by changing the track height and rocking the camera around the specimen axis of rotation.

Considerable care must be taken in specimen preparation (*12*). The crushed sample is passed through 200-mesh bolting cloth and is mixed with a few drops of collodion diluted 1:10 with amyl acetate. If the material has a high absorption it is mounted on a 0.008-in. Lindemann glass fibre which is rolled in the *wet* mix. Petroleum jelly may be used if the collodion dissolves the specimen. A 0.005-in.-to-0.008-in. fibre is used for materials with moderate absorption and a capillary for materials with low absorption. The decrease in exposure time and resolution caused by using a capillary instead of a thin fibre for a quartz specimen may be seen by comparing Fig. 1d and 1e. All of these films have been purposely overexposed for the illustration and usable films may be obtained with shorter exposures.

Geiger Counter X-Ray Spectrometer. This instrument, based on the original design by the Braggs (*2*), was introduced about seven years ago and has found wide use in university and industrial laboratories where relatively accurate measurements of intensity and high resolution must be conveniently made. Its usefulness for quantitative analysis has also been demonstrated (*5*). A divergent beam of X-rays and a relatively large flat specimen 10 × 20 mm are used with a Geiger tube replacing the film as detector. The specimen is equidistant between the focal spot, which is the source slit, and the receiving slit in front of the Geiger tube (*1, 6*).

The X-ray optical arrangement of the newest instrument (*8*) is illustrated in Fig. 2. The line focus ($\psi = 3°$) is used with Soller slits (thin absorbing metal foils stacked in a parallel arrangement) to limit the divergence of the beam to a full angular aperture of 2½° in the plane perpendicular to the plane of Bragg focusing. The best resolution is obtained with a receiving slit at least as small as the projected size of the focal spot. Scatter slits (not shown) prevent the Geiger tube from detecting radiation not scattered from the specimen. The Geiger tube arm scans in the vertical plane, the radius of the goniometer is 170 mm, and the scanning range is −38° to +160° 2θ. The diffraction angles may be read to 0.01° in manual operation or angular intervals marked on the strip chart in automatic recording. The goniometer gear arrangement rotates the specimen at one-half the angular speed of the Geiger tube so that the center of the specimen is always tangent to the focusing circle. The use of a focusing arrangement gives high resolution and high intensities, since large angular apertures in the plane of Bragg focusing may be employed. For the range 20°–80° 2θ the angular aperture is 1° and it is increased to 4° in the back reflection region where the intensities are very much lower. The sensitivity of the Geiger tube is so high that very small angular apertures may be used to measure large *d* spacings.

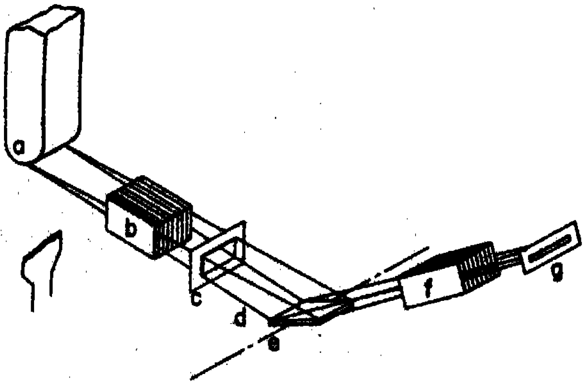

FIG. 2. Schematic X-ray optical arrangement of new spectrometer. *a*, X-ray tube line focus; *b*, *f*, Soller slits; *c*, divergence slit; *d*, Bragg focusing; *e*, specimen axis of rotation; *g*, receiving slit.

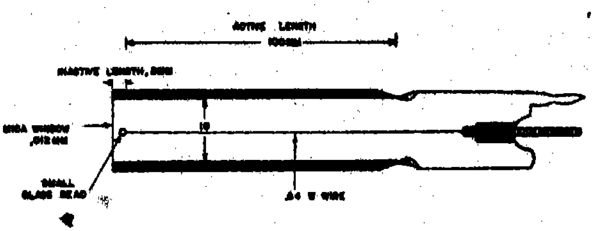

FIG. 3. Geiger counter for X-ray diffraction.

Geiger Counter Tube. The Geiger tube used for this application is shown in Fig. 3. The focused beam passes through the thin mica window along the wire anode for maximum absorption. The argon-filled counters give smoother and lower background than film (where the background is due to the shorter wavelength general radiation) because of the lower sensitivity in this region, whereas it is strongly absorbed by the film, particularly at low angles in the region of the Ag and Br absorption edges, as can be seen by broad bands around the 0° hole of the films in Fig. 1.

Electronic Circuits. A block diagram of the new circuits designed for measuring X-ray intensities with the Geiger tube is shown in Fig. 4. It is particularly important to regulate the X-ray supply in order to make correct relative intensity measurements, because the lines are scanned successively, whereas in the film method all lines are recorded continuously during the exposure.

The scaling circuit comprises eight scales-of-two which are plug-ins and are based on a modification of the conventional Eccles-Jordan type. The circuit has a resolving time of 6 to 7 microseconds (which is several times faster than currently available Geiger tubes) and will detect a pulse as small as −0.25 volt at the Geiger tube wire. For manual operation, the X-ray intensity can be measured either over a fixed time interval or the time measured to count a predetermined number of pulses. The advantage of the latter method is that the probable error (for counting alone) is the same for each measurement but a long time is required at a low counting rate.

The rate meter has a fixed full-scale range and operates from any selected stage of the scaling circuit. Therefore

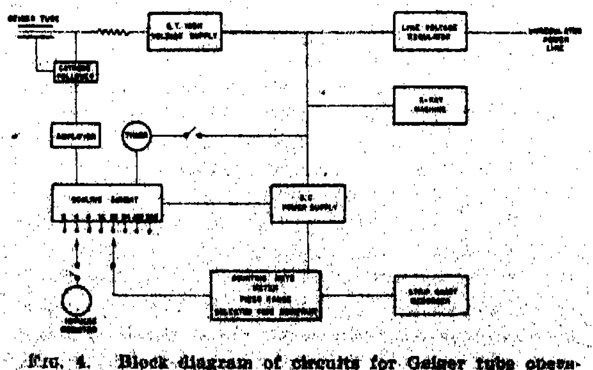

FIG. 4. Block diagram of circuits for Geiger tube operation.

each of the ranges is related to the other by an exact factor of two. A selector switch is provided to change the full-scale range from 50 to 40 or 30 cps, giving a total of 24 amplitude ranges with maximum counting rate of 12,800 cps. Five values of time constant (1 to 16 sec) are provided. The output of the rate meter can be read directly on a meter for survey work or recorded on a strip-chart recorder.

Intensity Calibration. Due to the limited resolving time of the Geiger tube and additional errors caused by automatic recording, it is necessary to calibrate the intensity measurement. This is easily done by means of a crystal plate and absorbing foils of equal thickness. The crystal plate is used in the specimen holder to monochromatize the beam. If a quartz plate (cut parallel to 10 · 1) and nickel foils (0.0007 in. thick) are used and the X-ray tube operated below 28 kvp, no difficulty will be caused by subharmonics ($\lambda/2$, $\lambda/3$, etc.) of the reflected beam. However, the calibration is accurate only for the kvp applied to the tube because the dead time of the Geiger tube measured in this way decreases with increasing kvp. Thus the difference in absorption of foils at the subharmonic wavelengths must be taken into account, or a crystal used having no reflection of higher orders.

For manual operation the intensity is measured with either the fixed count or fixed time method, depending upon the accuracy desired, for 1, 2 . . .*n* foils until the background is reached. The measured intensity in the form of counts per second is plotted on a logarithmic scale as a function of the number of foils on a linear scale. A straight line drawn through the points on the lower end of the intensity scale will then show where the measurements depart from linearity. For automatic operation the line is scanned from the same direction a few times for each number of foils and the average peak height is plotted instead of counts per second. A new calibration must be made if the scanning rate, time constant, amplitude range, or X-ray optics are changed, for these vary the measured intensity, peak position, and line shape. Unpublished work of Hamacher has shown that the peak counting rate is increased by a factor of two using full-wave rather than a half-wave rectified X-ray tube for the the same power input, and by three in operating the Geiger tube 300 v instead of 100 v above threshold.

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Two Radioactive Methods for Studying Certain Gas-Metal Reactions

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There are certain reactions between gases and metal surfaces yielding a solid reaction product which is deposited as a film over the surface of the metal. For example, the reactions between a clean aluminum surface and oxygen result in a thin oxide film spread over the metal surface. The usual method of studying the extent and rate of such film formation is the cumbersome and tedious "weight gain" technique. Two alternative methods, applicable to cases involving radioactive components, have been developed at K-25[1] for studying certain reactions of this type. These techniques, to be described, have proved extremely useful and convenient in studying the rate, the time dependence of the rate, the total magnitude of the reactions, and certain properties of the deposited films, and may have extension to other specialized investigations of similar nature.

Three criteria the particular reactions must satisfy for these methods to be applicable are: (a) The reacting gas must contain a radioactive component, (b) One product of the reaction must be a solid which adheres more or less firmly to the metal surface, and (c) The radioactive component of the gas must become a component of the solid reaction product. The number of reactions satisfying these requirements is not large, but such reactions are rather difficult to follow by regular methods.

An example of the type of reaction which may be studied by these methods is that which occurs between gaseous ruthenium pentafluoride and a clean metal surface, e.g., copper, under appropriate conditions. The pentafluoride is reduced to the nonvolatile trifluoride, which is deposited on the metal surface. The ruthenium may be obtained in a radioactive form (106) which emits beta particles at a satisfactory rate. Thus, all the stipulated requirements are met by this reaction.

Method 1. The metal involved in the gas-metal reaction to be studied is made into a Geiger-Müller or a proportional counting tube, say, 1 in. in diam and 10 in. long. A fine wire of the same metal (or alternately, of another metal inert to the gas involved), say 0.003 in. in diam, is suspended along the axis from insulators at the ends of the tube, to serve as the high voltage collector electrode of the counting tube. Suitable tubing, equipped with valves and filters, is provided for admitting and removing the corrosive gas.

The first step in studying a reaction is measuring the background counting rate, resulting from cosmic rays, contamination, etc. Then the radioactive, corrosive gas, suitably filtered, is admitted into the counting tube under the desired condition, left for a predetermined period of

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[1] This work performed under contract No. W-7405-Eng-26 for the Atomic Energy Commission at Carbide and Carbon Chemical Corporation plant K-25, at Oak Ridge, Tennessee.

particles which obey the Stokes-Cunningham law. Intense dark field illumination of the particles allows photography of a number of vibrating particles in a small fraction of a second. Our present apparatus employs standing waves of 5-kc frequency, generated by the type of oscillator described by H. F. St. Clair (*12*), and is applicable to particles from 1 to 5 μ in diam, while a 40-kc frequency will cover the range from 0.1 to 1 μ.

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A Contact Modulated Amplifier and Some of Its Laboratory Uses

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Developed to measure d-c signals on the order of a few hundredths of a microvolt, this amplifier employs motor-driven contacts to modulate the input signal (*2*). It features ruggedness, portability, stability, low noise level, and insensitivity to vibration.

Direct-current input signals are converted to a-c (80 cycles) by means of a mechanical breaker, stepped up in voltage by a transformer, amplified with several vacuum tube stages, and finally rectified by another breaker driven synchronously with the input breaker. This arrangement reduces the effect of random variations in the amplifier and favors the wanted signals introduced at the input.

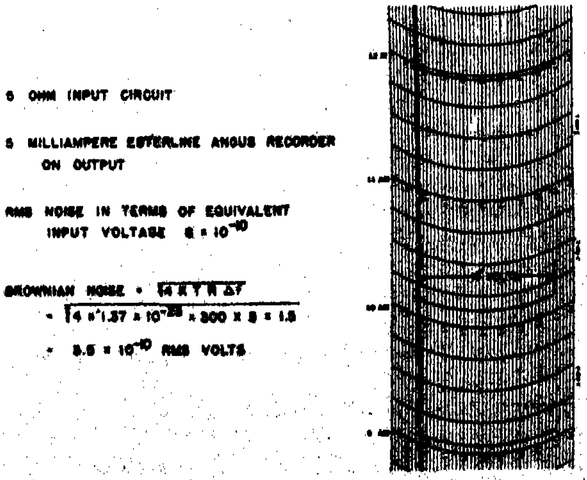

FIG. 1. Amplifier noise level and drift over a 8-hr period.

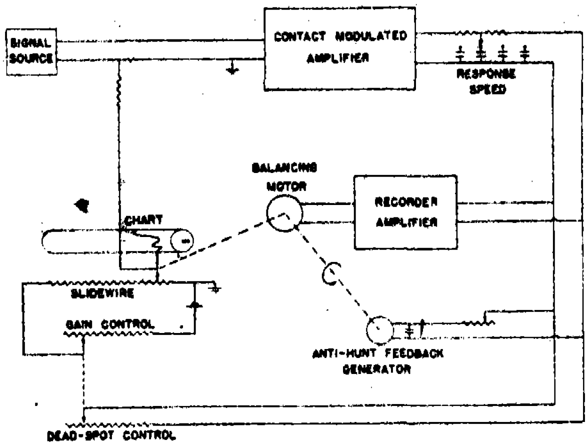

FIG. 2. Infrared spectrograph recording circuit.

Drift due to small temperature differences between components in the input circuit has been minimized by careful construction and selection of materials. Thermoelectric coefficients of the copper components in this part of the amplifier are matched and junctions are soldered with a special solder (70% Cd, 30% Sn) having a low thermo emf with respect to copper. The input transformer is magnetically shielded with multiple, concentric layers of Mumetal and soft iron.

Fig. 1 shows a performance record of the amplifier. A test signal of 10^{-7} v applied to the 5-ohm input circuit provides calibration from which the random noise level can be measured. An interesting comparison is made in Fig. 1 between the observed noise of 8×10^{-10} rms v and the Brownian noise due to thermal agitation in the input circuit. In the expression for Brownian noise:

K = Boltzman constant
T = Temperature in degrees Kelvin
R = Resistance of input circuit
Δf = Over-all band width (cycles) of amplifier and recorder.

The observed noise is only a little more than twice the theoretical minimum.

This amplifier has found one of its most important applications in the field of infrared spectroscopy. It is

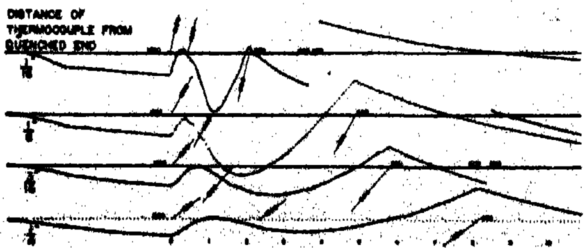

FIG. 3. Record obtained from end-quenched 1020 steel bar.

used with a variety of recording circuits (*4*) in several types of infrared spectrographs. The recording circuit shown in Fig. 2 employs the amplifier as a preamplifier for a self-balancing potentiometer type recorder. The features provided are: null balance, wide range of gain control, selection of response speed or band width, and antihunt control. A degree of sensitivity with stability is obtained which permits the recording of infinitesimal quantities of energy on recording instruments of the type commonly used in severe industrial surroundings such as steel mills and foundries.

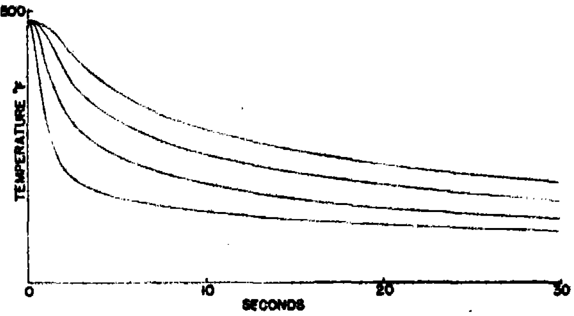

FIG. 4. Cooling curves as recomposed from data of Fig. 3.

In a system for studying quench processes in the heat treatment of steel, the amplifier is used with another recording circuit. Time-temperature cooling curves produced by thermocouples at four different locations on a steel bar are recorded during a quench. A method is employed wherein only small differential signals are recorded so that all four curves can be obtained simultaneously on a chart of convenient size while using high sensitivity for accuracy. The major portion of the signal from each thermocouple is bucked out by an opposing emf, which is continuously varied, approximately to cancel the thermocouple signal. During the initial rapid cooling period of the quench, the bucking signal is reduced linearly by a potentiometer driven synchronously with the drum carrying the chart. Fig. 3 shows the first ten sec of a quench record made in this manner. Zero time, as indicated on the time axis (horizontal) of the record, marks the beginning of the quench. The traces prior to zero time represent the cooling of the test bar as it was brought from the 1500° F furnace to the quenching bath. After completion of a quench the actual cooling curves as shown in Fig. 4 are obtained by combining the recorded difference deflections with the bucking signals employed. Cooling rates up to 1200° F per sec have been recorded.

In the oxyhemograph (*1, 3*), a device for recording directly the percent oxygen saturation of the hemoglobin of the blood, photocell signals are applied to the contact modulated amplifier. A photocell, placed on the opposite side of the pinna of the ear from a small light source, responds to changes in the light-transmitting property of blood, which varies with the percent oxygen saturation of the hemoglobin. The oxyhemograph has been found especially useful in the operating room during anesthesia for surgery. Fig. 5 shows sections of a record made in the operating room of the Henry Ford Hospital. The time between each vertical line on the chart is 30 sec. The upper edge of the chart represents 100% oxygen saturation of the blood, the lower edge 60%; below 60% is a dangerously low oxygen content. Each peak in the record on the top section of chart represents one respiration of the patient. The general level of blood oxygen content is low here (lowest point 77%), due to the action of the anesthetic. However, it is increased subsequently by permitting the patient to breathe a mixture of nitrous oxide and oxygen. It was learned, early in the work with the oxyhemograph, that strain on the patient is lessened if the blood oxygen saturation is maintained near normal (95%) during the operation.

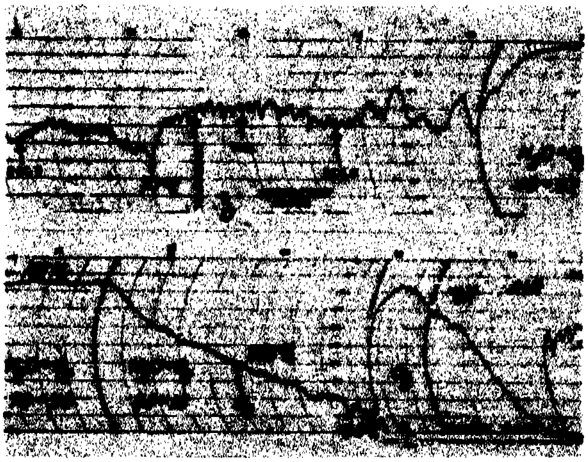

FIG. 5. Oxyhemograph record made with patient under anesthesia for surgery.

The bottom section of the chart shows how the patient's changing condition during the final critical phases of the operation is quickly reflected by the instrument. Blood oxygenation values fluctuate so rapidly and so widely that intermittent gas analysis determinations are inadequate.

The amplifier has found many other uses where high sensitivity is required in the neighborhood of vibration and disturbance.

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TECHNICAL PAPERS

Radiation Survey of X-Ray Output of an Electron Microscope from Personnel Hazard Viewpoint[1]

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In performing a general radiation survey of the physical plant of the Atomic Energy Project at the University of California at Los Angeles, it was noted that radiation well above background levels existed in the vicinity of the 50-kv electron microscope. Since a portion of the electron beam strikes various metal surfaces in the 'scope, continuous X-rays are generated. It is possible for the operator of the electron microscope to be exposed to this radiation through the various viewing apertures. The presence of this X-radiation from the electron microscope initiated a survey of the instrument for possible hazards.

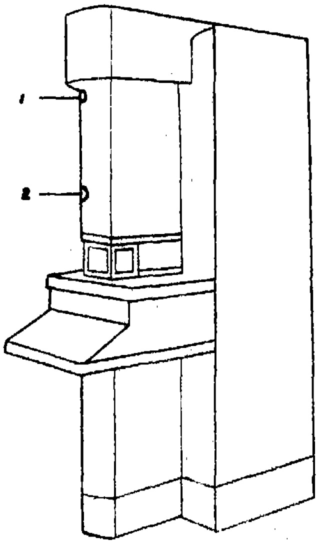

FIG. 1.

A calibrated Keleket dosimeter was placed so that the sensitive volume was in direct contact with the port of the primary viewing screen, (1 in Fig. 1). With the beam current of the electron microscope at 200 μa, the average dosage at this port was approximately 1500 mr/hr. If a person were exposed to this level a full working day, he would receive several hundred times the maximum permissible exposure. The dosage at the intermediate viewing port, (2 in Fig. 1), was 70 mr/hr. At this Atomic Energy Project, the maximum exposure permitted is 50 mr/day.

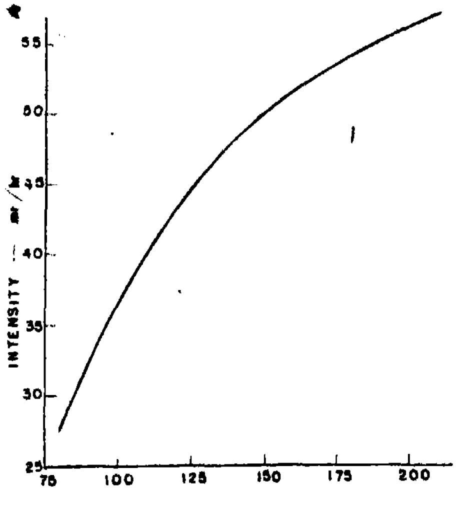

FIG. 2. Dosage vs. beam current at 20 cm.

The intensity of the X-rays was measured as a function of the beam current in the electron microscope. This was done by using a Victoreen Model 356 survey meter placed so that the nylon window of the ionization chamber was 20 cm from the port of the primary viewing screen. The data are shown in Fig. 2. The beam current commonly employed ranges from 100 to 300 μa. At 200 μa, the dosage at 20 cm would be about 56 mr/hr, which is approximately ten times the tolerance rate.

The hardness of the X-ray beam was determined by making a series of measurements with Al filters. Fig. 3 shows the results of these determinations.

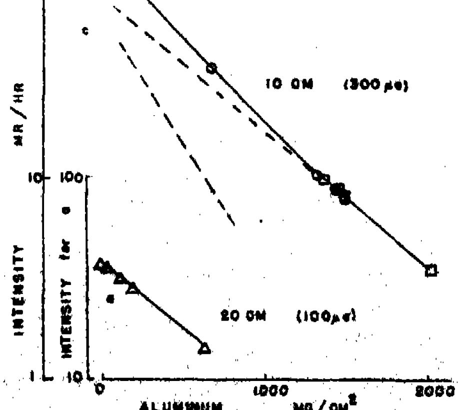

FIG. 3. Attenuation of X-rays from electron microscope.

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[1] This report is based on work performed under Contract No. AT-04-1-GEN-12 between the Atomic Energy Commission and the University of California at Los Angeles.

Curve (a) is a graph of the X-ray intensity in mr/hr plotted against the thickness of Al filter in mg/cm². These data were obtained by using the Model 356 meter. The beam current for this series of measurements was 100 μa, and the distance was 20 cm. This was a convenient set of values to use so that the middle range of the instrument could be employed.

Curve (b) is similar to curve (a) except that a Victoreen Model 247A meter was used. A beam current of 300 μa and a distance of 10 cm were convenient for this instrument. In curve (b) the circles represent the data obtained with the aluminum case of the instrument removed. The squares represent the data obtained with the aluminum case on the instrument. The consistency of these two sets of data indicated that the case was equivalent to 1.34 g/cm² of Al filter. In plotting the squares, this equivalent filter weight was added to the actual weights of the filters used.

The range of attenuation in curve (b) is sufficient to show a decrease in the slope of the curve with increasing weight of the Al filter. This change of slope is due to the fact that the softer components of the X-rays are filtered out more quickly than the more penetrating hard components remaining in the X-ray beam. To obtain an approximate estimate of the proportion of soft and hard components, curve (b) was analyzed in the usual way producing curves (c) and (d). Curve (c) represents the more rapidly attenuated soft component, and curve (d) the harder component. Since the X-rays are of the continuous type arising from the bombardment of bronze in the electron microscope by 50-kv electrons, the division of the X-rays into two components, hard and soft, is just a convenient approximation and is an empirical representation of the data.

Mass absorption coefficients, μ_m, computed from the slopes of the curves (a), (c), and (d) are tabulated:

Curve	μ_m *in cm²/g*	*Distance in cm*
(a)	1.5	20
(c)	2.5	10
(d)	1.5	10

This corresponds to half-value thicknesses of Al of 1.0 and 1.7 mm for the soft and hard components respectively. Apparently the X-rays at 20 cm from the port of the primary viewing screen are qualitatively like the hard component of the beam at 10 cm. Using standard tables for the mass absorption coefficient of Al, this set of values corresponds to a wavelength range of 0.45–0.50 A for the X-rays. This is approximately the wavelength range in which one may expect to find the peak energy for a continuous X-ray spectrum arising from 50-kv electrons (*1*).

A ½-in.-thick plug of lead glass was placed in each viewing port. The dosage at the ports was then reduced to less than 1 mr/hr. The high dosage had been due to the accidental use of ordinary glass instead of lead glass in the assembly of this instrument by the manufacturer.

It is suggested that electron microscopists survey the radiation from the viewing ports to determine whether or not the X-ray intensity exceeds the accepted tolerance dosage.

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Airborne Magnetometer for Measuring the Earth's Magnetic Vector

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An airborne instrument which continuously records geomagnetic information from which all magnetic components may be determined has been developed at the Naval Ordnance Laboratory. The instrument is a modified form of the airborne total field magnetometer developed by the Naval Ordnance Laboratory and Bell Telephone Laboratories during World War II for the location of submerged submarines by the detection of their anomalous fields. Since the war, this submarine detector, with slight changes, has been used for geophysical prospecting.

The basic feature of the new magnetometer is that it now determines the total magnetic field vector instead of only the intensity. This is done by measuring the intensity and the direction of the total magnetic field vector with respect to a set of coordinate axes stabilized with respect to the surface of the earth.

The sensitive measuring element of the magnetometer is a saturable inductor which is excited by a 1000-c current of sufficient amplitude to saturate its permalloy core. A 2000-c voltage is generated by the inductor, the amplitude of which is proportional to the strength of the magnetic field along its axis. The inductor is mounted in a gimbaled arrangement driven by servo motors to maintain its detection axis parallel to the earth's magnetic field. The gimbaled arrangement with its servo motors is called the detector head and is secured to the frame of the aircraft. Potentiometers and their associated electronic circuits measure the amount of angular displacement of the detection element about the two axes of the gimbals in which the detector is carried. By means of these angles the total magnetic field vector can be projected onto a system of coordinate axes fixed with respect to the aircraft.

In order to make use of these data, the orientation of the aircraft with respect to vertical and true north must be determined. A vertical reference is provided by a gyroscope controlled by gravity-actuated devices so as to maintain the spin axis of the rotor of the gyroscope vertical. Potentiometers on the roll and pitch axes of the gyroscope measure the inclination of the aircraft with respect to vertical. These angular measurements are used to refer the magnetic data to a coordinate system stabilized with respect to the surface of the earth.

The true heading of the aircraft is obtained by periodic astral observations. A continuously recording directional gyroscope maintains a record of the aircraft heading between astral observations. The position of the aircraft is determined by one or a combination of astral observations, loran fixes, radar, visual observation, and photography, depending upon the area to be surveyed.

During flight the total magnetic field intensity, the aircraft heading, and the angular displacements about the gimbal axes of the detector head and the gyro vertical are continuously recorded by graphic milliammeters. The process of determining the various magnetic quantities from these data is carried out after the flight is completed.

The vertical reference gyroscope used to measure the inclination of the aircraft is subject to certain errors so an alternate system for establishing a vertical reference was developed employing an oil-damped pendulum. The pendulum will produce true readings only when the aircraft is in a state of nonaccelerated flight. The directional and vertical gyroscopes are used, therefore, to ascertain when the accelerations due to changing attitude are at a minimum. Points are selected during these periods for computing the magnetic quantities.

In order for the magnetometer to be employed to the greatest advantage, a stable aircraft and smooth flight conditions are required.

Charts showing the components of the earth's magnetic field are issued periodically by the Navy Hydrographic Office and the U. S. Coast and Geodetic Survey. The angle of declination or magnetic variation is of primary importance because of its requirement for navigational purposes. The other components, angle of dip, total intensity, and vertical and horizontal fields were formerly of more or less academic interest but are now finding increasing use in specialized fields of research, development, and geophysical exploration.

Up to the present time, the great bulk of magnetic surveys for chart-making purposes have been conducted employing instruments consisting of rotating coils or the deflection and oscillation of small magnets. Although these instruments are capable of highly precise measurements on the ground, they have not been particularly adaptable for use in aircraft for the determination of the earth's complete magnetic field vector. They also require that surveys be conducted on a point-by-point basis, which is time-consuming.

Surveys of oceanic areas have been made with similar types of instruments and have required the use of nonmagnetic ships. Such measurements were terminated in 1929 when the only existing nonmagnetic vessel, the "Carnegie," burned off the island of Samoa. Similar to ground measurements, the data taken at sea is a point-by-point process with one set of observations made each 200 to 300 miles. Measurements made at sea, however, were less accurate than those made on land.

The airborne measurements are expected to be of the order of accuracy of those made at sea. The airborne surveys, however, will have the advantage of greater speed, continuous recording, and the avoidance of small magnetic anomalies near the surface of the earth.

Due to the constantly changing nature of the earth's magnetic field, the problem of tying a large number of observations made at widely separated times to a common time base should be considerably simplified with the use of airborne instruments due to the fact that vast areas may be mapped in a short period of time.

At the present time the magnetometer is limited to operation in areas of dip angles of about 50° and greater. With additional development the range of operation can be extended to all areas of the earth. Only one instrument has been constructed, and it is undergoing flight tests at the present time.

Avoiding Trial-and-Error in Inframicroscopic Photography[1]

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The phenomenal surge of interest in the general field of photography that preceded World War II was not followed as closely as might have been expected by a corresponding development in photomicrography. New lenses and other factors produced an infinite variety of "close-ups" achieved with techniques which were used to scientific advantage but were pursued largely as a hobby, to obtain unusual patterns in subject matter. The field of photomicrography scarcely developed in these years beyond the needs of those who required the technique for teaching purposes or to illustrate scientific publications.

Strictly speaking, this was true of America more than of Europe, owing, perhaps, to the available equipment there, particularly that of German origin. For some years before the war even the person who pursued photomicrography as a hobby was accustomed to replacing the lens of his Leica with a suitably threaded adapter, which contained a shutter and an indirect-vision aperture and which fitted, in turn, the eyepiece of the microscope. In this instance all three elements—the camera, the adapter, and the microscope—were manufactured by the same firm, Ernst Leitz of Wetzlar, although adapting devices were generally available for most cameras. Much of the work in America was, and still is, accomplished by connecting the camera to the microscope by means of a flexible sleeve, often an automobile radiator hose. While excellent photographs can be obtained with this simple device, the technique has certain serious disadvantages, particularly in regard to stability and variable focusing, difficulties which now can be remedied with several types of standard equipment.

Between the range of the close-up and that of true photomicrography there lies another field of invaluable and fascinating photography which invites further exploration: the photomagnification of objects grossly visible to the naked eye. It is a range that may be defined as that lying between the scope of normal human vision at 10 in. and that of actual low power photomicrography.

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[1] Use of this particular camera does not imply its endorsement by the U. S. Public Health Service.

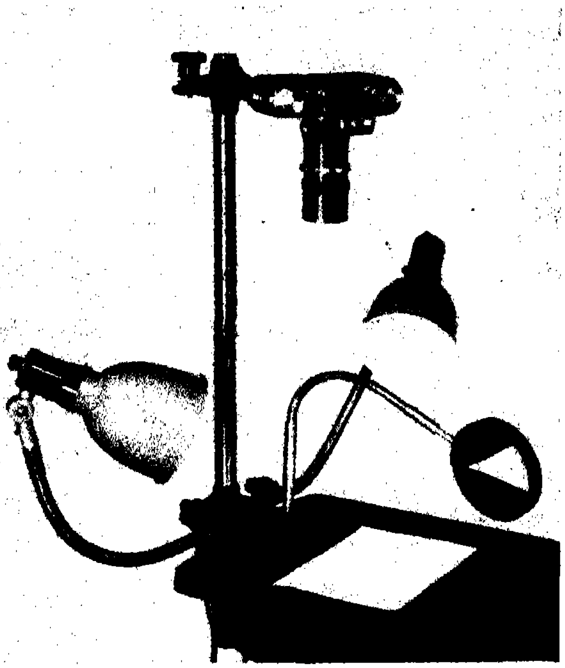

FIG. 1. Alpa reflex camera mounted for close-up photography.

In some European technical literature the range has been defined as "macrophotography" (also, and more correctly, "photomacrography") although we may quarrel with the use of these terms, which specify all photography below the microscopic range. Perhaps the term "inframicroscopic photography" might describe this undefined area. As a functional field it chiefly covers the study of surface structure, animate or inanimate, and was first introduced in popular photography in terms of such subjects as razor blade edges, cactus spine points, and insect wings. The technique rapidly became a valuable scientific tool in all spheres, from botany to ballistics.

Certain unique problems face the scientist or hobbyist who pursues photography in this range, particularly if the material to be studied varies in texture, translucency, color, or depth. These difficulties are unique because they greatly exceed those found in either normal photography or photomicrography, where lighting and focusing are more constant factors. With these problems specifically in mind, cameras and accessories have been devised to meet the requirements of this highly variable intermediate range.

The Swiss-made Alpa-Reflex is one of these cameras, with precision accessories cleverly contrived to fill the needs of every range of photography from infinity to microscopic. It is literally an all-purpose, 35-mm miniature camera (24×36 mm) ideally suited to general outdoor photography and to photomicrography, as well as to the perplexing inframicroscopic field. Equipped with mirror reflex focusing, eye-level view finder, complete range finder, and a standard 5-cm coated lens, the flash-synchronized focal plane shutter allows time exposures as well as a scale extending from 1 sec to 1/1000 sec. A small but valuable feature is that the exposure setting can be read at any time, since the setting knob does not rotate when the shutter is released. Coated and color-corrected lenses with focal lengths 3½–18 cm are available and can be easily adjusted, being fixed in bayonet mounts. Unusually long helical screws of 20-mm range permit exceedingly close-up focusing with ease. To adapt the camera to photomicrography nothing more is needed than a clamping ring which fits—or can be ordered to fit—the extension tube of any microscope, while a complete survey of the microscopic image is provided by the ground glass screen in the reflex view finder.

It is the intermediate field of the so-called macrographs to which the Alpa-Reflex is particularly suited (Fig. 1). It must be remembered that in photographing objects that are in one plane, as a smooth surface, a lens of standard focal length should be used in preference to a wide-angle lens. In three-dimensional subjects a better perspective is produced by increasing the focal length of the standard lens. The reproduction ratio should be selected with the size of the ultimate enlargement in mind. All surfaces have a limit in the degree of possible magnification, beyond which further detail is lost, a definite limit of resolvability beyond which no more finite detail can be distinguished. In the case of three-dimensional objects, where the depth of the field is the essential factor, only the questions of perspective and lighting determine the focal length, since the depth of focus is the same for the reproduction ratio regardless of the focal length.

Such problems, which may be exasperatingly difficult to solve with improvised equipment, particularly when color film is used, are reduced to a minimum with supplementary lenses. To begin at the scale of normal photography, the standard focal length 5-cm lens, having a 3-mm range of adjustment, allows a focus ranging from infinity to 1 meter. To focus under 1 meter, extension tubes usually are provided with a +1 D supplementary lens to cover the gaps in range left as the result of using the tubes. However, the function of the main lens is considerably impaired by supplementary lenses; hence the desirability of using interchangeable lenses of greater focal length (7½–18 cm), in which case the usual supplementary lenses of shorter focal length are unnecessary. The intermediate tubes provide a continuous range of supplementary extension.

The versatility of this equipment, designed with the problems of inframicroscopic photography in mind, obviates the discouraging and wasteful trial-and-error methods of focusing and lighting and justifies the initial expenditure.

Improvements in the Making of Special Photographic Emulsions for Nuclear Physics

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In 1945 (1) the author prepared concentrated, very fine-grained emulsions such as emulsion formula 2 (*2*), in which it has proved possible to record, with good detail and discrimination, the tracks of fission fragments (*3*), alpha rays, protons, and even of slow electrons (*1, 2*). Experience has shown us that the properties of these emulsions are not easily reproduced (*4*). The critical factors have been found to be: the mechanical and stoichiometric conditions during the mixing operation; the temperature of the wash water, which should be preferably below 5° C; and the gelatine used.

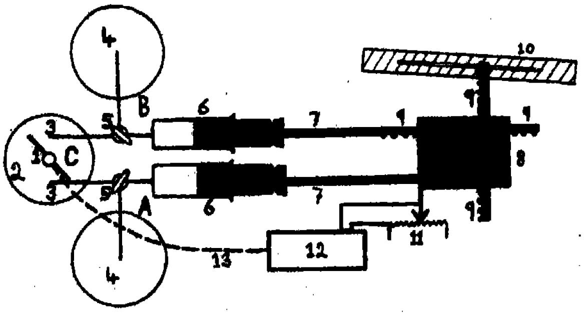

FIG. 1. Schematic view from above of emulsion-making machine. Sliding parts are shown in heavy black. Part 1 represents a stirrer; 2, a beaker containing solution C; 3, pouring tips; 4, tanks of solutions A and B; 5, three-way stopcocks; 6, 100-ml syringes; 7, pushing rods; 8, sliding carriage (bench carrying 8 and motor moving it are not shown); 9, right angle racks sliding inside 8 and linked through pinion (not shown); 10, sheet with slot guiding the movement of racks 9; 11, potentiometer regulating speed of motor 12; 13, flexible shaft from motor 12 to stirrer 1.

To control mechanical and stoichiometric factors, a machine has been designed and built that is illustrated schematically in Fig 1. To the stirred C solution, solutions A (600 g $AgNO_3$/1000 ml solution) and B (420 g KBr/1000 ml of solution) are added simultaneously, through the action of syringes, pushing rods, and carriage, moved by a motor sliding along a bench. Volumes of solutions A and B are kept constantly equivalent or nearly so, B being in slight excess. The double rack mechanism with its guiding slot introduces an adjustable difference between the movements of the pistons of syringes containing A and B, and thus allows one to cope with a difference of diameter between pistons, and with inaccuracies of concentrations of A and B. Also, through the peculiar shape of the slot chosen, it is possible to vary the excess (B-A) at will during mixing. The system also fills up syringes when they are empty. Here are numerical data for solution C: 15 g gelatine, 167 ml water, and 33 ml ethyl alcohol; use at 40–50° C. First add 1.3 ml of B. Then deliver at equivalent rates 100 ml of A and B, taking 2–3 min. Increase the stirring rate from 240 to 550 rpm. Chill and set at 0–2° C (1 hr). Break the jelly in small pieces and wash at 0–2° C (1 hr). Collect, melt, coat, dry, and sensitize 1 min in 6% triethanolamine before use.

In this method, the mixing phase is highly critical but there is no high temperature treatment. In preparing ordinary emulsions, mixing may be less critical but the heat treatment is a delicate phase.

This machine has been used with uniformly good results. A prototype of it, using 30% syringe sizes and quantities in mixing, has been in operation for nearly a year with consistently good results. Under its standardized conditions, 13 gelatine samples have been tried, and all gave good tracks of alpha rays and protons, and at least a peculiar granular appearance with radium D electrons. The best electron tracks (40–60 kv) resulted from gelatines labeled "fast negative," that is, from gelatines recommended for obtaining the greatest light sensitivity.

This gives us further reason to believe that similar active centers are essential both for light and for ionizing particles. Still unexplained is the lack of connection noted between light and particle sensitivity for various emulsions, which probably depends on the disposition of active centers on the AgBr grains.

This work was supported by the National Research Council, and a detailed report of it will be sent to the Canadian Journal of Research.

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Sensitivity of Gamma-Ray Counters[1]

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Radioisotopes can be investigated in many cases only by detection of their gamma radiation. Measurements of the distribution and the amount of an isotope used for tracer studies or for therapeutic purposes are often based on counting the gamma rays emitted in a certain direction (*3*). The sizes of source and gamma-ray counter, and the distance between them, determine the fraction of the total gamma radiation which is incident on the detector. The actual number of registered counts is again only a fraction of the incident gamma rays, depending on the sensitivity of the counter. It is known that even counters made from high atomic material detect only 0.7–2% of the gamma rays with energies between 0.5–3.0 Mev when the gamma radiation penetrates the counter walls perpendicularly (*2*). This low counter sensitivity is a serious limitation for many investigations. Different methods which result in a higher counting sensitivity will be outlined here.

Somewhat higher sensitivities can be obtained by using

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[1] Supported in part by a grant from the Office of Naval Research.

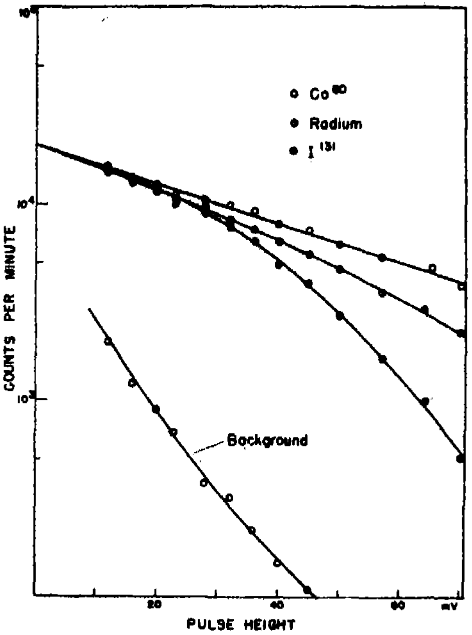

Fig. 1.

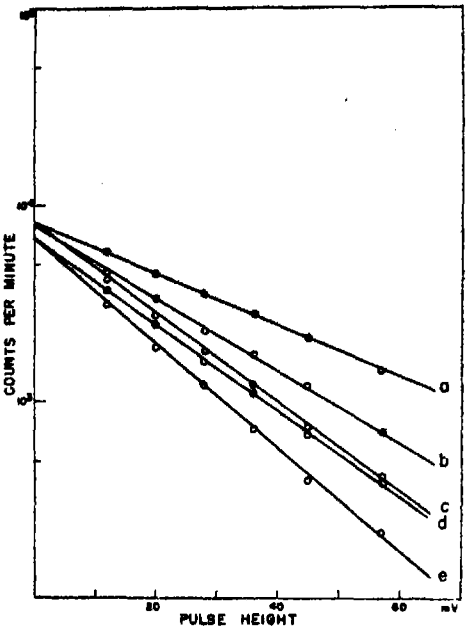

Fig. 2.

Geiger-Müller counters end-on. The probability for the secondary electrons, produced by the gamma rays in the counter walls, to enter the sensitive volume of the counter increases when the gamma rays strike the walls at a small incident angle. With calibrated I^{131}, Co^{60}, and radium sources, sensitivities of about 2% for I^{131}, and 4% for Co^{60} and radium were observed with commercial end-window tubes, such as the North American Philips No. 62019. The same results were obtained with a multicellular type of counter.[1]

A large number of organic and inorganic crystals have come into use recently as scintillation counters (*1, 4*). The gamma rays absorbed in the crystal produce light flashes, which are detected and amplified by a photomultiplier tube. Due to their high density and high atomic weight components, calcium tungstate crystals show a very high gamma-ray sensitivity. Under conditions described herein, sensitivities of 24%, 38%, and 36% for Co^{60}, radium, and I^{131} gamma rays, respectively, were observed, with highly polished, clear crystals[2] of area ⅜ × ⅜ in. and thickness ⅛ in.

A 1P21 photomultiplier tube operating at about 90 v per stage and the $CaWO_4$ crystal were kept at room temperature. A model 500 Los Alamos preamplifier and discriminator, together with a scaling circuit, counted photomultiplier pulses greater than 12 mv. Fig. 1 shows the counting rate versus integral pulse height for Co^{60}, Ra, and I^{131} sources. The tube background, also given in Fig. 1, has been subtracted from the source measurements, which were adjusted to the same extrapolated counting rate. The three curves indicate the differences in gamma-ray spectra of the three isotopes.

Taking into account only the primary gamma rays entering *the crystal through its front surface (⅜ × ⅜ in.)*, the percent crystal sensitivities mentioned were obtained. For the ⅛ in.-thick $CaWO_4$ crystal, the sensitivity for I^{131} corresponds to the expected gamma-ray absorption in the crystal. However, the Co^{60} and Ra sensitivities are at least twice that expected from the absorption of the incident primary gamma rays alone. Since these results were found to be independent of the resolving time of the counting equipment, which was varied from 5 to 300 μsec, the $CaWO_4$ crystal used under these conditions caused no double pulsing.

All three pulse height distributions of Fig. 1 were obtained with a Lucite rod, 1 in. in diam and 4 in. long, placed between the crystal and the photomultiplier tube. The $CaWO_4$ crystal was covered with an Al foil as reflector, except for the surface touching the Lucite rod. Fig. 2 shows how the radium pulse height distribution is affected by varying this arrangement.

Curve (a) of Fig. 2 repeats the results with the radium source given in Fig. 1. Curve (b) was obtained when the Lucite rod was removed and the crystal was mounted directly on the photomultiplier tube but without being covered with Al foil. The decrease in large pulse heights shows that the light absorption in the Lucite is smaller than the amount of light gained by the Al foil. Curve (c) shows a further decrease in light intensity when the Lucite rod was again placed between crystal and photomultiplier but without using the Al foil reflector.

All three curves intersect at about the same extrapolated counting rate. This indicates that the results were not affected by a change of the crystal arrangement when the extrapolated counting rates were used. The application of the Lucite rod provides a better geometry for most investigations. Its replacement by a quartz rod would improve the light conduction.

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[1] U. S. Patent #2,397,661, The Texas Company.

[2] The Linde Air Products Company, Tonawanda, N. Y.

Finally, curves (d) and (e) of Fig. 2 show the results for the crystal placed with the $\frac{1}{2}$ in. × $\frac{1}{2}$ in. surface facing the Lucite rod, with and without Al foil. In this position the surface area and therefore the number of incident primary gamma rays was only $\frac{1}{4}$ as compared with the conditions for curves (a), (b), and (c). The extrapolated counting rates, however, were nearly the same as before. The crystal sensitivity, therefore, seems to increase in proportion to the crystal thickness. These results are in agreement with the approximately 100% sensitivity for Ra gamma rays reported by Moon (*4*), for a $CaWO_4$ crystal about $\frac{3}{8}$ in. thick.

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Adapter For Visual Monitoring with Portable Geiger-Müller Equipment

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The application of a neon-filled strobotron (SN4) tube as a visual means of continuous monitoring of areas in which radioactive materials are used has proved itself very convenient.

Fig. 1 is the schematic diagram of a circuit developed for using an SN4 (manufactured by Sylvania Electric Company) as a visual indication of instantaneous changes in counts, that may be due to contamination or changes in background.

The circuit is enclosed in a metal box which has a large bull's-eye lens directly in front of the SN4. This circuit was developed to operate directly from the earphone jack of the Herback and Rademan Geiger-Müller Radiation Measuring Set, Model GLR-200.

The signal is superimposed on a d-c voltage which in effect produces a pulsating d-c voltage having a positive sign. The d-c voltage is adjusted to a value just below the firing point of the OA4 by sensitivity control R7. Thus, the incoming signal increases the potential of the d-c value to a point that will cause this tube to fire.

Resistor R6 has to be of a value that will keep the potential on the starter anode at the same value as the cathode, and yet of high enough value to prevent excessive loading of the output stage of the Geiger-Müller circuit.

When the OA4 fires, condenser C2 is momentarily shorted to ground through resistor R4, at the same time the plate voltage is reduced to a value which will not support operation. With the OA4 in an extinguished state, condenser C2 recharges through R5, thus impressing a positive voltage of sufficient value on the starter anode of the SN4 to cause it to fire. The SN4 will become extinguished when the potential of C1 falls below the critical operational potential. Following these events C1 becomes recharged through R1, thus conditioning the circuit for another firing sequence.

The operation of the circuit is dependent upon the height of the voltage pulse from the output stage of the Geiger-Müller circuit. This pulse must have a value of not less than 5 v.

The sensitivity of the instrument is directly dependent upon the Geiger-Müller tube used and the preliminary cir-

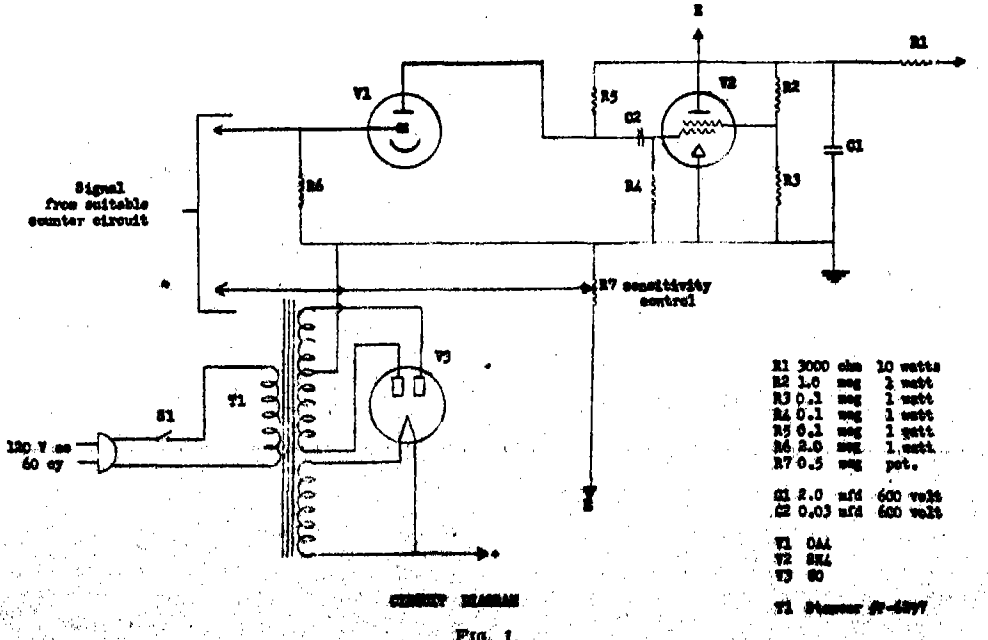

Fig. 1.

cuit. In our laboratory a Radiation Counter Laboratory Type 10A Beta-Ray Counter Tube obtained from Tracerlab, Boston, Massachusetts, having a glass wall of 30 mg/cm², or about 0.12 mm thick, is used. With the setup described, 3 μc of P^{32}, I^{131}, and Ra salts give a flash rate about twice background, at a source distance of 25 cm.

The OA4 tube was selected as it has characteristics that require small wattage for operation.

As the pulse sequence of the circuit is very short, having a duration of a few microseconds, the 8N4 was selected for its very high illuminating intensity.

No attempt has been made to develop a quantitative measuring instrument, as the primary requisite is for detecting infinitesimal amounts of radioactive substances on clothing, hands, glassware, sinks, and counter tops around the laboratory.

(Continued from page 352)

summarized a paper by Van Lear and Long, describing an American commercial Raman spectrograph.

Other physical measurement methods were described by Madame Y. Cauchois, of the Laboratory of Physical Chemistry, Paris, who gave two papers—one on new developments of bent crystal techniques and one on curved crystal X-ray spectroscopy. In the same section A. Guinier, also from Paris, talked about demountable tubes and cameras for X-ray crystallography and some recent techniques in X-ray metallography.

Among the mechanical measurements discussed were two methods for photographic recording of ultrahigh speed phenomena by explosions, described by C. H. Johansson, of Detoniklaboratoriet, Stockholm. In one, instantaneous photographs are taken with an ordinary camera, using sparks or flash lamps as light source and a Schlieren apparatus. By repetition, lighting at successive time intervals being reckoned from the start of the explosion, *quantitative measurements of the velocity at different* stages of the occurrence can be made. Intervals from 2 to 500 microseconds are obtained by a detonation fuse. Other papers in this section included one by Robert Schnurmann, of the Manchester Oil Refinery, Ltd., England, on lubricant testing methods, and one by Pierre Piganiol, of the St. Gobain Company, Paris, on the measurement of the melt viscosity of plastic materials.

In the division of industrial control, R. S. Medlock, of the British firm George Kent, Ltd., spoke on the analysis of oxygen, based on its paramagnetic properties. With the exception of nitric oxide, oxygen appears to be the only strongly paramagnetic gas, and this affords a physical method of measurement. Other lectures included two by W. F. Hanson, of the Du Pont Company, and Maurice Surdin, chief of electrical construction services for the French Atomic Energy Commission.

Papers on metrology included one by Rene Yribarren, of Société d'Application de Metrologie Industrielle, Paris, who spoke on "Some Considerations About Accurate Fits." He described the contribution of the Solex air-operated method to the present problems of industrial metrology. All of the apparatus he described had the same object, he said—to incorporate inspection within the machining department, and to make measuring techniques formerly used for judging into guides for production. Other papers were read by A. Metz, of Ernst Leitz, Wetzlar, Germany, and Karel Veska, of Kovo Ltd., Prague, Czechoslovakia.

As part of the conference, a fairly large exhibit had been arranged, with a floor area of more than 30,000 square feet. Among the exhibitors were the French Atomic Energy Establishment, the French Defense Research Establishment, the German East Zone, and several of the main instrument manufacturing firms in Sweden. The greater part of the exhibit was commercial.

Perhaps the most interesting part of the exhibit was that arranged by the Swedish State Council of Technical Research in cooperation with the Academy of Engineering Sciences and the Association of Technical Physicists. Here was shown instrumentation research under way in Swedish institutions and laboratories. The committee on large computing machines showed parts from their project on a binary relay machine.

Other computing machines shown at the exhibit included an analogue computer for aircraft stability problems, an automatic recording Fourier synthesis apparatus, and parts from a mechanical differential analyzer with four integrating units, under construction at the Chalmers Institute of Technology.

New developments of direct-reading pH-meters, usable for all types of potentiometric measurements, and polarographs with a maximal sensitivity for full-scale diffraction of 0.0033 microamperes were shown by the Chemical Institution of the University of Upsala.

The Department of Telegraphy and Telephony at the Royal Institute of Technology had a wide range of apparatus, among which may be mentioned an automatic impedance meter for automatic recording of locus diagrams of networks within the range of 100 to 15,000 kilocycles per second, a heterodyne filter that can be used as a band-pass filter with continuously variable high and low frequency cutoff, that has an attenuation of 1 to 2 cycles per decibel.

In the field of electronics the Department of Electronics at the Royal Institute of Technology showed a 37-Mev synchrotron and a new development of the trochotron for pulse counting. The counting rate of a scale built with this new tube is 10 megacycles per second.

The Department of Electronics at Chalmers Institute of Technology showed experiments on radio wave propagation, a radar search for meteors, and the latest development in the traveling wave tube.

By special invitation, the U. S. National Bureau of Standards, the National Research Council of Canada, the RCA Research Laboratories and the Bell Telephone Laboratories had arranged booths in this part of the exhibit.

NEWS and Notes

D. B. Anderson, professor of plant physiology and assistant director of the Graduate School at North Carolina State College, has been made head of the Department of Botany, effective September 1.

Otto A. Reinking, professor and head of the Division of Plant Pathology, New York State Agricultural Experiment Station, Cornell University, has just returned from a research trip on diseases of abaca which took him to Tawau, British North Borneo, and Davao, Philippine Islands.

Douglas M. Kelley has resigned his position as associate professor of psychiatry and director of the Psychiatric Hospital at the Bowman Gray School of Medicine, Wake Forest College, to become professor of criminology at the University of California, Berkeley. Dr. Kelley will give courses in criminologic psychiatry and detection of deception.

Wilhelm Spannhake, senior scientist at the David Taylor Model Basin, Bureau of Ships, Washington, D. C., has joined the staffs of Armour Research Foundation and the Graduate School of Illinois Institute of Technology. Dr. Spannhake is the author of *Centrifugal pumps, turbines, and propellors; basic theory and characteristics.*

T. P. Ting, of the Department of Biology at Amherst College, has been appointed research associate professor of physiology at the University of Saskatchewan. Dr. Ting will conduct radiobiological research with the 25-Mev betatron recently developed at the University of Saskatoon.

Arthur J. Bedell, professor emeritus of ophthalmology, Albany Medical College, will deliver the fourth William Hamlin Wilder Memorial Lecture of the Institute of Medicine of Chicago at a joint meeting with the Chicago Ophthalmological Society on October 14. His subject will be "Medical Ophthalmology: A Kodachrome Demonstration of Fundus Photographs of Diabetes, Hypertension, Nephritis, Optic Neuritis, and Choked Disc."

Walsh McDermott, associate professor of medicine, Cornell University Medical College, will deliver the third William Allen Pusey Memorial Lecture of the Institute of Medicine of Chicago at a joint meeting with the Chicago Society of Internal Medicine on October 28. His subject will be "Antimicrobial Therapy."

Hartmut Kallmann, former professor of physics at the Technische Hochschule in Berlin-Charlottenburg and head of the Department of Physics at the Kaiser Wilhelm Institute at Berlin-Dahlem, has been appointed professor of physics at New York University. Dr. Kallmann will continue his research on the scintillation counter, conductivity-counting, and fluorescence.

Charlotte Moore-Sitterly, of the National Bureau of Standards' spectroscopy laboratory, has been elected an associate of the Royal Astronomical Society of Great Britain. Dr. Sitterly was honored for her contributions in the fields of astronomy and astrophysics, particularly her extensive compilations of multiplet tables and her work in identifying lines in solar and sun spot spectra. She is the first woman to receive this distinction, although the late Annie J. Cannon, of the Harvard College Observatory, was an honorary member of the society.

Visitors to U. S.

Herman M. Kalckar, research professor of the University Institute of Cellular Physiology, Copenhagen, will deliver the first Harvey Lecture of the current series at the New York Academy of Medicine on October 27. Dr. Kalckar will speak on "Enzymatic Reactions in Purine Metabolism."

C. F. Tipper, of the Engineering Laboratory, Cambridge, England, is dividing ten weeks in this country between work on strength of metals at the Naval Research Laboratory, Washington, D. C., and visits to other scientific laboratories. During and following the war, in addition to her teaching at Cambridge University, Dr. Tipper worked on deformation and fracture of practical engineering metals. She will lecture on "Correlation of Test Results" at the Metals Congress in Cleveland on October 19.

Grants and Awards

The Max Planck medal for scientific achievement was awarded on September 23 to Lise Meitner, of the Royal Swedish Academy of Sciences in Stockholm, and Otto Hahn, professor at Gottingen University. The medal, which is the highest award of the German Society of Physicists, was presented at Bonn University, Germany.

The Franklin Medal, highest honor given by the Franklin Institute of Pennsylvania, will be presented this year to Theodor H. E. Svedberg, director of the Gustaf Werner Institute for Nuclear Chemistry, Upsala, Sweden. The medal, which will be presented October 19 in a ceremony at the institute, is in recognition of Dr. Svedberg's development of the ultracentrifuge in determining molecular weights and other achievements in the field of colloid chemistry. Former winners of the medal include Thomas A. Edison, Guglielmo Marconi, Albert Einstein, and Sir Robert Robinson.

Fellowships

The Life Insurance Medical Research Fund will accept applications for 1950 grants-in-aid of cardiovascular research up to *January 1, 1950.* Approximately $550,000 will be awarded in support of physiological, biochemical, and pathological research bearing on cardiovascular problems, as well as for clinical research in this field. Preference is given to fundamental research.

At least 12 postgraduate fellowships between $3,000 and $4,000 are also available for research training, with larger amounts available in special cases. An M.D. or Ph.D. degree, or the equivalent, is required and applications for 1950–51 will be accepted up to *January 1.* A number of predoctoral fellowships for basic training in research will also be awarded. Applications and further information may be secured from the Scientific Director, Life Insurance Medical Research Fund, 2 East 103 Street, New York City 29.

Colleges and Universities

Wayne University will present its sixth annual lecture series, "Frontiers of Chemistry," cosponsored by the International Society of the Friends of the Kresge-Hooker Libraary, on consecutive Monday evenings, beginning October 10. Lecturers and their topics will be: *Charles Smyth*, Princeton University Physics Department, "Molecular Orientation and Dielectric Behavior in Liquids and Solids"; *W. Conard Fernelius*, Department of Chemistry, Pennsylvania State College, "Some Current Problems in the Structure of Coordination Compounds"; *N. H. Furman*, Department of Chemistry, Princeton University, "Electrical Methods of Chemical Analysis"; *Paul D. Bartlett*, Department of Chemistry, Harvard University, topic to be announced; *Lee Irvin Smith*, School of Chemistry, University of Minnesota, "The Chemistry of Some Cyclopropanes"; *A. L. Lehninger*, Department of Surgery, University of Chicago, "The Enzymatic Oxidation of Fatty Acids"; *Maurice L. Huggins*, Research Laboratories, Eastman Kodak Company, "Properties of Long-Chain Compounds"; and *D. C. Grahame*, Department of Chemistry, Amherst College, "Progress and Problems in the Study of Electrical Double Layer."

The noncredit registration fee for the series is $5.00 and checks, made payable to Wayne University, should be mailed to J. Russell Bright, chairman of Wayne's Chemistry Department. Qualified persons may arrange for graduate credit of one or two hours.

The University of Cincinnati has opened a new psychosomatic ward at Cincinnati General Hospital. Patients will be admitted with high blood pressure, stomach ulcers, asthma, diabetes, colitis, or other ailments not completely explained by physical causes. The new ward will aid in training and research in psychosomatic medicine. Maurice Levine, head of the university's Department of Psychiatry, and M. A. Blankenhorn, head of the Department of Internal Medicine, will be directors of the new ward.

Meetings and Elections

The Conference of Professors of Preventive Medicine will hold its annual meeting October 24 at the Hotel Statler, New York City. Health officers, personnel from graduate public health fields, and other interested persons are invited to attend. Programs are available upon request from Leland W. Parr, George Washington University Medical School, Washington, D. C., or from David Rutstein, Harvard Medical School, Boston.

The International Congress of Military Medicine and Pharmacy will be held October 23–29 in Mexico City. Maj. Gen. Raymond W. Bliss, Army Surgeon General, and his deputy, Maj. Gen. George E. Armstrong, will participate in the program, and several scientific papers will be presented by Army, Navy and Air Force delegates.

The Indiana Academy of Science will hold its fall meeting November 3–5 at Wabash College, Crawfordsville, Indiana. Papers will be presented in the 11 divisions of the academy. C. L. Porter, of Purdue University, will give the presidential address.

A symposium on water problems of the process industries will be held by the **New York Section of the American Institute of Chemical Engineers** on November 17 at the Hotel Statler, New York City. Topics to be discussed include substitution of air or seawater for surface water cooling towers, water treatment to reduce scaling, applications of compression distillation, and a survey of the economics of supplying water to the plant.

The American Society of Ichthyologists and Herpetologists elected the following officers at its 29th annual meeting: John Treadwell Nichols and Helen T. Gaige, honorary presidents; M. Graham Netting, president; George S. Myers, F. H. Stoye, and Fred R. Cagle, vice presidents; Edward C. Raney, secretary; Lionel A. Walford, publications secretary; and Dwight A. Webster, treasurer.

The 295th meeting of the **American Physical Society** will be held at the University of Chicago, November 25–26. Sessions of invited papers will be presented by the Divisions of Electron Physics and of Solid-State Physics. Hotel headquarters will be the Sherman Hotel and members should make their reservations by letter to Miss Ruth Brown, Sherman Hotel, Randolph at Clark Street, Chicago.

Deaths

Frederick MacAllister, 74, retired professor of botany at the University of Texas, died in Austin on January 7. At the time of his death, Dr. MacAllister was preparing a monograph on the mosses and liverworts included in his extensive collection.

Alonzo E. Taylor, 78, pathologist and internationally known agricultural economist, died May 20 at his home in Palo Alto after a short illness. Dr. Taylor joined the Stanford Food Research Institute as director in 1921 and resigned as director emeritus in 1936. Much of his time was devoted to research in the international relations of food supplies.

Robert Gordon Sinclair, 46, Craine professor of biochemistry at Queen's University, Kingston, Ontario, Canada, died August 17 as the result of a swimming accident in Lake Ontario. Dr. Sinclair had been at Queen's since 1937 and had previously held the rank of associate professor of biochemistry at the University of Rochester. He was well known for his basic studies on the metabolism of phospholipides.

John D. Long, 75, traveling representive of the Pan American Sanitary Commission, died in Guayaquil, Ecuador on September 18. Dr. Long was formerly director of health in the Philippines, chief quarantine officer of the Panama Canal Zone, vice director of the Pan American Sanitary Commission, and vice president of the Far Eastern Tropical Medicine Institute.

Cobb Pilcher, 44, brain surgeon, and associate professor of neurosurgery at Vanderbilt University Medical School, died September 22 of a heart attack. Dr. Pilcher had conducted extensive research in the treatment of Jacksonian epilepsy and brain infections, and in work with vascular lesions of the nervous system.

The Oak Ridge Institute of Nuclear Studies will present three additional basic courses in the techniques of using radioisotopes as tracers this winter. They will be held January 2–27, January 30–February 25, and March 6–31, 1950. Thirty-two participants will be accepted for each course. Application for the January 2 course should be mailed prior to *December 1.*

Each session is divided into laboratory work, lectures on laboratory experiments, general background lectures, and special topic seminars. Experiments will be conducted covering the use and calibration of instruments and the purification and separation of radioactive materials from inert materials and from other radioactive materials. Other laboratory work will be devoted to the application of various radioisotope techniques.

Seminar topics include the use of tracers in animal and human experimentation, design of radiochemical laboratories, dosimetry, instrumentation, the effects of radiation on living cells, and the principles and practices of radiation protection.

A registration fee of $25.00 is charged for each participant. Hotel or dormitory facilities are available in Oak Ridge.

Application forms and additional information may be obtained from Dr. Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tennessee.

The National Research Council's Committee on the American Type Culture Collection, which was appointed to study the problems of adequate financial support of the ATCC, has recommended increasing the price of cultures to make the maintenance and distribution of the collection cultures self-supporting.

The ATCC has been supported since its beginning by gifts as well as by sales. With continually rising costs the new policy was considered preferable to requesting gifts annually from industry. The price increase will be much less for educational institutions, in keeping with the ATCC's objective to provide an essential service to microbiology.

Beginning January, 1950, the price of cultures will be ten dollars each, with a discount of 70% to educational and charitable institutions, and to organizations or individuals whose activities primarily concern the public welfare.

The National Research Council committee is continuing its studies to insure permanence to the collection and to increase its usefulness.

The American Society of Zoologists, which meets December 28–30 with the AAAS in New York City, has extended its deadline for demonstration program papers to *October 25.* Papers should be sent to the secretary, Walter N. Hess, Hamilton College, Clinton, New York.

The ***South African Journal of Science,*** formerly a yearly volume of papers read at the annual congress of the South African Association for the Advancement of Science, has begun monthly publication. The new journal will no longer be confined to the publication of material presented at the annual meeting of the association, but will print short articles and comments on current affairs, letters to the editor, reports of meetings, and book reviews.

A provisional advisory committee on science abstracting for Unesco during the year following the publication of the report of the International Conference on Science Abstracting will be composed of: *S. Bhagavantam,* scientific liaison officer, India House, London; *Pierre Bourgeois,* director, Bibliotheque Nationale Suisse, Bern; *Verner W. Clapp,* chief assistant librarian, Library of Congress, Washington, D. C.; *J. E. Cummins,* chief scientific liaison officer for Australia, Africa House, London; *G. M. Findlay,* editor, *World Abstracts,* London; *H. R. Kruyt,* Technische Natuurwetenschappelijk Onderzoek, Netherland; *L. H. Lampitt,* chairman, Bureau of Abstracts, London; *Bertil Lindblad,* director, Stockholms Observatorium, Saltsjobaden, Sweden; *Miguel Osorio de Almeida,* director of the Department of Physiology, Institut Oswaldo Cruz, Rio de Janeiro; and *Jean Wyart,* Faculté des Sciences, Paris.

Make Plans for—

Seminar for the Study and Practice of Dental Medicine, October 23–28, Desert Inn, Palm Springs, California.

American Society for Horticultural Science, October 26–28, Milwaukee, Wisconsin.

A conference on mechanisms and evaluation of antiseptic activity, sponsored by the Biology Section of the New York Academy of Sciences, October 28–29, New York Academy of Sciences, New York City.

Second Annual Nucleonics Symposium, sponsored by the Institute of Radio Engineers and the American Institute of Electrical Engineers, October 31–November 2, Hotel Commodore, New York City.

Status of AAAS Meeting Reservations

The early and heavy demand for *single* rooms already indicates a potential shortage of this type of accommodations at the **116th Meeting of the AAAS in New York City,** December 26–31. There are plenty of hotel rooms but many have double or twin beds. Miss Sylvia T. Peltonen, Manager, Housing Bureau, New York Convention and Visitors Bureau, 500 Park Avenue, New York 22, who is in charge of room assignments, urges that, when possible, room reservations be placed by parties of two or more. This also has the advantage of a lower cost per person. Room reservation coupons will appear in the advertising pages of *Science* at frequent intervals.

Chromatography: A Perspective

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IN 1906 the Russian botanist, Tswett, published in the proceedings of the German Botanical Society (*30*) a description of a new technique for separating the components of complex mixtures. This technique, which was based on the partition of solutes between a stationary solid adsorbent and a moving liquid phase, was dealt with more comprehensively in a later work in Russian (*31*). It consisted simply of pouring a small quantity of the solution of pigments, such as green leaf pigments, on the top of a vertical column of adsorbent and following this with pure solvent, whereupon a series of colored bands formed down the length of the column in a sequence determined by mass relationships and adsorption coefficients. Tswett named his technique the "chromatographic method."

Unfortunately the chromatographic method got off to a bad start. In the first place, Tswett's book was published in Russian, and his original paper was published in a botanical journal, as were several later ones. Hence much of his work did not receive wide notice by chemists. In the second place, many of his publications at that time were somewhat polemic in nature. In reading the abstracts of his publications one cannot help but feel in Tswett a vigorous individualism, which probably grated on the sensibilities of the chemical hierarchy. Tswett had a clear conception of the tremendous scope of his discovery and such implicit faith in the procedure that against all opposition he insisted doggedly upon the presence of two components in chlorophyll and in the "phaeophytin" of that period. But for a lowly botanist to assault thus the whole chemical profession was unthinkable! Although a few isolated remarks appeared in favor of Tswett's work, the chromatographic method fell largely into disrepute, and, according to Zechmeister (*33*), Tswett spent the latter part of his life in misery and poverty.

Chromatography was not revived until 1931, under the stimulus of rather widespread researches on the carotenoids. In the intervening period only infrequent references to the technique can be found. Palmer, in his monograph on the carotenoids (*16*) published in 1922, speaks very highly of the technique and refers to several of Tswett's publications. The importance of the carotenoids as precursors of vitamin A was not realized, however, until 1928, when Euler and co-workers (*8*) pointed out that pure carotene, lycopin, and certain other carotenoids showed the same characteristic reaction with antimony trichloride in chloroform as did vitamin A. They further demonstrated the pronounced activity of carotenoids as growth factors and were able to show a definite relationship (*9*) between the antimony trichloride reaction, carotene content, and vitamin A potency. This new incentive led several investigators to undertake intensive studies in this field, and in 1931 Kuhn and Lederer (*13*) described the separation of carotenoids from several natural sources by "adsorption analysis" on fibrous alumina. This was followed two years later by publications by Karrer and Morf (*11*) and Karrer and Walker (*12*) describing the separation of α- and β-carotenes on calcium oxide or hydroxide. Then in 1934 two articles by Strain (*22, 23*) appeared, setting forth the excellent properties of magnesium oxide as an adsorbent for the separation of α- and β-carotenes. Strain concluded that there was no support for the view that α- and β-carotenes are artifacts arising from the action of the adsorbent. These observations appear to have broken the back of any remaining opposition to the method initiated by Tswett, and numerous publications continued to flow from the pens of Karrer and co-workers, Strain, and others.

From the early 1930's to the present day, chromatography has continued to develop in a multiplicity of directions, aided by numerous ingenious devices and refinements in technique, so that there is no longer a single branch of chemistry that has not profitably employed this separational procedure. In the words of Paul Karrer in his lecture at the International Congress of Pure and Applied Chemistry (London, 1947), quoted recently by Tiselius (*29*):

> No other discovery has exerted such a great influence and widened the field of investigation of the organic chemist as much as Tswett's chromatographic analysis. Research in the field of vitamins and hormones, carotenoids, and numerous other natural components could never have progressed so rapidly and achieved such great results if it had not been for this new method, which has also disclosed the enormous variety of closely related compounds in nature.

It is beyond the scope of this paper to treat individually of each important development or useful variation in the method. An excellent review of the more important developments is given in a recent publication by Strain (*25*). A general perspective of the scope of modern chromatography, as well as some insight into possible future developments, may be gained, however, by considering the process from the standpoint of competing equilibria and by making a classification on this basis. Such a classification assumes complete reversibility in the interactions taking place—a condition occasionally not fulfilled and, for certain applications, not always necessary. But in the general case the stationary adsorbent and the mobile fluid (which may be either gaseous or liquid) compete with each other for the solutes originally present in the fluid phase. Such a classification is given in Table 1.

TABLE 1

Primary mode of action	Class	Type of competitive interaction: Mobile phase	Solid phase	Representative phenomena*
Ionic: (solubility product, instability constant, etc.)	1	Ions	Ions	Ion exchange
	2	Complex	Ions	Ion exchange
	3	Ions	Complex	Inorganic chromatography
	4	Complex	Complex	(Not reported)
	5	Ions	Dispersion	Fractional decomposition methods
	6	Complex	Dispersion	Fractional decomposition methods
	7	Dispersion	Dispersion	Diffusion of colloids, macromolecules
	8	Ions	Association	Electrokinetics
	9	Dispersion	Ions	(Not reported)
	10	Dispersion	Complex	(Not reported)
Nonionic: H-bonding; dipole, and/or induced dipole; geometry of molecules (partition coefficients)	11	Association	Association	Organic (and partition) chromatography
	12	Association	Dispersion	Catalytic polymerization
	13	Association	Ions	Catalytic dissociation
	14	Association	Complex	(Not reported)
	15	Complex	Association	(Not reported)
	16	Dispersion	Association	Salting-out adsorption

* The items in this column are admittedly incomplete and dependent primarily on the author's limited knowledge. The reader may be able to suggest phenomena that could be included in the spaces labeled "not reported."

In this table the following definitions apply:

Ion: A solute particle having a definite electrical charge and characterized by a simple structure and subcolloidal dimensions.

Complex: The product of a reversible interaction between a solute particle of simple structure and a complexing agent to form a new species. The combination usually involves linkages of an auxiliary, or coordinate, character. The complex may itself be a simple structure (charged or uncharged), or it may be a relatively large and complicated aggregation of particles appearing as a colloidal dispersion, as a precipitate, or as an immobile deposit on the solid phase.

Dispersion: The product of a reversible interaction of a solute with another solute, or with the solvent itself, to produce a species having a decreased association with the solvent. This decrease in association becomes evident in the aggregation of particles to form a colloidal dispersion or a visible precipitate.* In this discussion the term dispersion is not intended to include those dispersons arising from a process of complexing as described in the preceding paragraph. It does, however, include dispersions of proteins, silicates, soaps, dyes, organic polymers, and other particles which may or may not be ionically charged, depending upon pH, adsorption or occlusion of ions, presence of dissociable groups, etc.

Association: A mutual attraction between a solute particle and another substance (either in the liquid or solid phase, or both), or between two solute particles of the same species, which does not involve the establishment of fixed bonds. This interaction is characterized, rather, as a loosely bound complex of indeterminate composition arising from the geometry of the molecules involved, from dipole and induced dipole interactions, from resonating electrostatic attractions, or from other imperfectly understood factors. The "bond energies" involved, insofar as this term may be applied here, lie in the neighborhood of 2 to 8 kilocalories per mole, as contrasted with the much greater bond energies involved in the types of aggregation discussed previously.

A casual study of these types of interaction will reveal that the selection is to some extent arbitrary. It is difficult or impossible to assign quantitative definitions to these terms. Yet the phenomena they represent are real, and their selection is based on their suggestiveness of these phenomena in accordance with current usage. Consequently, they are employed here as descriptive titles rather than as terms of exact definition. As such, they are paired in Table 1 to form sixteen possible combinations that theoretically may give rise to competing equilibria by means of their relationships to the mobile phase and the solid phase. The title gives the key to the type of relationship existing. Each pair describes a class. Several of the classes represented will be recognized as already popular in chromatographic methods. Others are just being introduced, or have not as yet been suggested. It is the purpose of the following paragraphs to consider briefly the development and prospects of chromatography as related to these classes.

Class 1: Chromatography by ion exchange has been widely studied. Schwab and co-workers have done considerable pioneering in this field (*19, 20*) and have applied inorganic chromatography as an adjunct in microanalysis (*18*). Perhaps one of the most impressive applications of this method is the concentration of the isotopes of potassium, lithium, and nitrogen by Taylor and Urey (*27, 28*) using columns of zeolites. The relative adsorption affinities of ions appear to depend primarily on valence, degree of hydration, and basicity. The separation of zirconium and hafnium on an ion exchange resin has been announced recently (*26*), development being carried out with 6 M hydrochloric acid. The more basic hafnium appears first in the effluent.

Class 2: An important refinement of simple ion exchange chromatography is described in considerable detail by Spedding, Boyd, Tompkins, and others (*21*). These investigators employed buffered citrate solutions in the chromatographic development of rare earth mixtures on synthetic ion exchange resins. The competition between resin and complexing agent for the individual elements gives rise to a separation depending mainly on relative basicities. It was found possible to separate in a comparatively small number of operations various mixtures of rare earth elements into spectroscopically pure individuals. To obtain a similar result by older methods requires as much as a thousand fractional recrystallizations. The chromatography of fission product mixtures has led to the first positive chemical identification of isotopes of element 61 (*14*).

Class 3: By reversing the system described as Class 2 and selecting a complexing agent for the solid phase it is again possible to achieve separation of ions. Erlenmeyer and Dahn (*7*) have pioneered in this method, employing 8-hydroxyquinoline as the "adsorbent." The position of several metals are recognizable on the column by the colored complexes they form. The pH of the liquid phase is an important factor, since the stabilities of the complexes are directly related to it. The use of this method does not seem to be widespread, possibly because of the limited number of complexing agents possessing favorable characteristics and also because even 8-hydroxyquinoline itself tends to be displaced from the solid phase during the process of development. It would seem that these difficulties could be overcome by "fixing" the complexing agent irreversibly on another solid. Silica, for example, might be precipitated in the presence of 8-hydroxyquinoline to form an "oxinated" silica with the desired characteristics. Much developmental work is obviously possible.

Class 4: Finally, competing equilibria may be established between a complex in the mobile phase and a complex in the solid phase. A mixture of citrate complexes, for example, might be chromatographed on a column of 8-hydroxyquinoline. Here again, the separation will depend on the basicity of the complexed ion, and the sequence of zones should be predictable on the basis of ionic crystal radii. While this method increases the separational possibilities included under the first three classes, no work seems to have been done on it.

Class 5: A solution of cations by chromatographic development may be induced to precipitate in colloidal form through a gradual increase in pH. The colloidal material, being less mobile than the original ions, is retained in the interstices of the adsorbent as a "zone." This mechanism has been pointed out recently by Meinhard and Hall (*15*), and it is felt that some of the previously reported inorganic separations regarded as proceeding by simple ion exchange in reality occur by this process. The method is limited at present primarily to analytical applications on a micro or semimicro scale. Its success will depend on refinements in technique which lead to reliable quantitative estimations.

Class 6: The system described as Class 5 may be modified by first complexing the original ions. The mechanism will then involve decomposition of the complex prior to the precipitation of a zone. Separations will be based on the relative stabilities of complexes and the mobility of the complexing agent. This system should not be confused with Class 15, in which the complex is adsorbed as such on the column. Where the chromatography of simple ions does not lead to a useful separation, a complexing agent may be employed to modify both the sequence and the sharpness of definition of the zones. Little work appears to have been done on this type of separation (*10*) and the formation of a less mobile species by hydrolysis seems to have been largely overlooked.

Class 7: Chromatographic methods so far do not seem to have found much application in the separation of proteins and other macromolecules or molecular aggregates. In this classification the extent of aggregation of the colloid in the liquid phase is often different from, and usually less than, its aggregation when in contact with the solid adsorbent. Unfortunately, proteins are often irreversibly adsorbed and may suffer denaturation at the solid-liquid interface. Adsorption studies on enzymes initiated by Willstätter (*32*), and his school, have resulted in certain successful separations on alumina and silica gel, but such adsorbents cannot be applied generally. An obvious suggestion here, and one that apparently has not been reported, is the chromatography of protein dispersions using as the immobile phase a solid protein structure. Such a structure would seem to be capable of a maximum degree of specificity combined with a maximum degree of "gentleness" toward the adsorbate.

A somewhat different application of this method has been employed recently in the purification of zirconyl salts (*1*). This procedure depends on the formation of the hydrous oxide of zirconium when zirconyl nitrate is dissolved in water at moderate concentrations. The hydrous oxide exists in colloidal form and is nonionic. By passing the solution through an ion exchange column all ions existing as impurities are retained, while the zirconyl colloid appears quantitatively in the effluent. A similar process has been indicated (*4*) for the commercial preparation of silica dispersions. A solution of sodium silicate is developed on an acid-treated ion exchange resin, which retains the sodium ion and releases a salt-free colloidal silicic acid.

Class 8: When a solid does not contain individual ionic centers of attraction its activity toward the passage of a solution of ions is manifested in the electrokinetic effect. Here the ions are associated with the solid in a postulated electric double layer. A recent description of the process is given by Bikerman (*2*). The effect becomes prominent only at very low concentrations and, in the case of uni-univalent electrolytes, is proportional to the concentration$^{-1/2}$. It is difficult to see how such a system could be made the basis of a useful chromatographic method, especially in view of the high potency of ion exchange media. It is interesting, however, to consider this effect in relation to the migration of ions in soils and other geological formations.

Class 9: The chromatography of a colloidal dispersion which combines ionically with the adsorbent has been suggested for proteins using an ion exchange resin (*29*). The reaction of the colloid with ion exchange media might be predictable on the basis of its interaction with other ionic species. It is impossible, however, to assess the potential value of such a method in the absence of experimental data. An interesting possibility is present in the case of insoluble inorganic salts. If an aqueous dispersion of barium sulfate, for example, is chromatographed on an acid-treated cation exchange resin, the barium ion should be adsorbed while sulfuric acid appears in the effluent. Development of the column may be continued using a different acid, the net result being a barium salt whose original anion has been replaced. The chromatographic separation thus accomplished is one of cations from anions. A separation of a mixture of cations obviously can take place at the same time. Such an application should find use in certain analytical schemes where sulfate, or other anions, are objectionable and difficult to eliminate.

Class 10: If for the ion exchange resin of Class 9 a complexing agent is substituted, still another chromatographic system is obtained. If it is desired to chromatograph on 8-hydroxyquinoline a mixture of metals obtained as difficultly soluble salts, one may add them as a dispersion directly to the column rather than resorting to additional operations designed to convert them to a more soluble form. Using a buffer solution as the developing solvent, the original anions may be carried into the effluent and the metal zones themselves may be separated. Such a method, of course, has only a limited usefulness.

Class 11: Chromatography owes its present popularity primarily to its tremendous success in the field of organic chemistry. In this classification the usurping effects of ionic charges are present to a negligible degree only, and separations become dependent on the associations of the solutes with solvent and adsorbent. Since differences in degree of association may arise from minute structural alterations, separations are based on structure alone. The separation of *cis*- and *trans*-isomers, and of optically active isomers, eloquently demonstrates the potency of this method. One of the foremost publications on chromatography, especially with respect to organic separations, is the book by Zechmeister and Cholnoky: *Die chromatographische Adsorptionsmethode* (*34*). In spite of the extensive studies made in this realm, chromatography still remains largely an art rather than a science (*24*).

Partition chromatography also may be placed in this category. Here the "solid" phase is actually a stationary immiscible liquid phase, and the rate of migration of the solute is a function of its partition coefficient in the two liquids. The filter paper chromatography of protein hydrolyzates initiated by Consden, Gordon, and Martin (*3*) is an example of this method that has attained widespread use. It should be pointed out, however, that the partition chromatography mechanism is valid in a more general sense. It is generally agreed from independent experiments that retention of liquid at a solid-liquid interface may extend to a depth of as much as a hundred molecules or more, provided the solid is "wetted" by the liquid. In viscous flow such a layer may be regarded as a "stationary" phase. Further, the structure of the stationary liquid is distinctly modified by the proximity of the adsorbent, thus completing the resemblance to an immiscible liquid phase. It will be seen, therefore, that the difference between ordinary chromatography and partition chromatography depends primarily on the selection of media and not on the mechanism involved.

Class 12: The catalytic effect of an adsorbent on a given solute molecule occasionally results in polymerization to a species which forms colloidal aggregates. This material may be adsorbed irreversibly or it may wander down the column at a sufficiently modified rate that a separation may be effected from another solute not similarly acted upon. The use of such a method is distinctly limited, especially since the polymerization process is in most cases irreversible.

Class 13: An adsorbent may also cause catalytic dissociation of a solute molecule with the formation of an ionic species in the adsorbate. Here again the process may be irreversible. By development with a sufficiently polar solvent, however, recombination of ions may occur, resulting in an equilibrium process. Obviously, in certain cases such a recombination may give rise to a more complex mixture than the original material. The process has been made the basis of various separations, however, in certain types of partition chromatography where a solvolytic ionization takes place in the aqueous phase. Elsden (*5*), for example, has separated mixtures of fatty acids in chloroform on a silica gel column, using bromcresol green as a column indicator.

Class 14: The employment of a solid phase which forms a complex with an organic solute does not appear to have been reported. Picric acid is suggested here as a complexing agent which might be used as the "adsorbent." Since it is soluble in organic solvents, it must first be rendered immobile either by the introduction of hydrophilic groups into the molecule or by irreversible adsorption on a suitable solid. Such a modified adsorbent may then be used in the chromatography of aromatic hydrocarbons, ethers, etc., the separation depending upon the relative stabilities of the corresponding picrates. Inasmuch as such picrates are often highly colored, the progress of a zone down the column may be readily traced. Other similar complexing agents include *sym*-trinitrobenzene, picrolonic acid, styphnic acid. Mercury salts might be used in the chromatography of certain unsaturated compounds; and such materials as calcium chloride and aluminum chloride, could be used in the separation of aliphatic ethers. For the separation of halogen derivatives, the use of ion exchange resins containing amine and imine groups is possible. All of these systems require essentially anhydrous conditions in order to avoid complications of an ionic character.

Class 15: The solubility of various metal complexes, such as the dithizonates, in organic solvents has led to a number of extraction procedures of analytical value. Little has been done, however, with the chromatography of such solutions. The separation of heavy metal dithizonates on alumina has been reported (*6*) as partially successful, but the use of other complexes in this manner has not been described. It is felt that further investigation of this method should be rewarded by useful separations which are especially applicable in trace-metal analysis.

In this same category partition chromatography is also possible. Such a system would involve the percolation of an organic solution of complexes through a column of silica gel, or other suitable water-retentive adsorbent. It might be suggested that this method be included in Class 4 except that here we are concerned primarily with the association of complexes rather than the competition between two different complexing agents. These systems may be reversed by employing an organic solvent in the solid phase and using an aqueous solution of complexes for the mobile phase.

The chromatography of aqueous solutions of metal complexes on hydrophilic adsorbents which have been pretreated with the complexing agent has been described (*35*). Where these complexes are ionic in character (e.g., the metal ammine complexes) this system becomes one of simple ion exchange and properly belongs in Class 1; where they are uncharged (e.g., soluble chelate complexes) the migration of the complex is governed primarily by its association with the adsorbent and may be included here. The developing solvent in these cases also contains the complexing agent, and the separation of zones results from a competition between the aqueous phase and the adsorbent for the complexed material. That is, dissociation of the complex itself is not a material factor in the process, as it is in Classes 2, 3, and 4. These fields of application are untouched.

Class 16: The chromatography of colloidal dispersions is beset with a number of difficulties, including the possibility of the presence of an almost limitless number of molecular species (e.g., polymers) and of widely varying degrees of aggregation. A phenomenon has been suggested recently by Tiselius (*29*), however, which promises to assist materially in the chromatography of proteins, namely, "salting-out" adsorption. Proteins of low adsorption affinity may be strongly bound to the solid phase in the presence of a salting-out agent such as ammonium sulfate. The exact nature of the association of the protein with the adsorbent is not known, but where the strength of association varies with different proteins the basis of a chromatographic separation is established. The elution of separate proteins may be carried out simply by varying the salt concentration in the developing solvent. The success of the method requires, of course, complete reversibility among the species present.

Some progress in the chromatography of particulates ranging from virus to bacterial size has been made, and its application has been demonstrated recently (*17*) in the separation of certain subcellular, enzymatically active granules. This separation was accomplished on columns of Celite, using aqueous solutions of sodium chloride as developing solvents. The mechanism here, also, is apparently one of salting-out adsorption, inasmuch as the original adsorption was accomplished under the influence of a much higher salt concentration than was used in the development of the column. Obviously, such a procedure is of value in amplifying, or supplanting, centrifugal methods of separation.

It will be apparent to investigators familiar with chromatographic methods that the scheme advanced above is somewhat oversimplified. It often happens, for example, that two or more of the types of interaction given here occur simultaneously in varying degrees on a single chromatogram. Conversely, because the exact nature and properties of certain solute particles are not well understood, it becomes difficult to place their chromatographic behavior in a specific class. It is also apparent that many of the significant advances in instrumentation have been omitted. For a description of these, the reader is referred to the several excellent reviews and monographs on the subject.

This tabulation is designed primarily to fulfill two purposes. It is intended, first, to point out those directions in which the greatest advances in chromatography have taken place and to reveal some of the reasons for these advances. Second, it is intended to suggest other applications which have not been tried, or which have been only briefly examined, with the hope of indicating some probable areas of future research.

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TECHNICAL PAPERS

The Proteins of Mammalian Spermatozoa and Cellular Nuclei[1]

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Since the early work of Miescher, Kossel, and others, cellular nuclei and fish spermatozoa have been known to contain a basic protein (either histone or protamine) and nucleic acid. Miescher (*8*) and Mathews (*3*) were unable to demonstrate the presence of histones or protamines in bull spermatozoa.

Mayer and Gulick (*4*) separated thymus nuclei by using Behrens' technique and extracted from the nuclei, by means of warm 3% NaOH solution, a protein fraction which precipitated when the solution was brought to about pH 6. They also extracted another fraction from thymus nuclei with a warm 5% NaCl solution. This material was precipitated by dialysis.

Mirsky and Pollister (*5*, *6*) used 1 M NaCl to extract from minced tissues a nuclear material which was precipitated by dialysis or dilution. In addition to histone and nucleic acid, the extracts contained in suspension a tryptophane-containing protein fraction. They were unable, however, to extract this material from bull spermatozoa (*6*). Mirsky and Ris (*7*) later identified a "residual protein," obtained from isolated chromosomes, with this tryptophane-containing protein fraction. The residual protein was insoluble in any medium which leaves proteins intact.

Stedman and Stedman (*9*) found a protein fraction other than histone in cellular nuclei. This protein fraction, which they called "chromosomin," was reported (*10*) to be insoluble in dilute acids and alkalies. It required from 1 to 3 days for dissolution in 1.0 N NaOH solution. The "chromosomin" from cod spermatozoa was found to contain 9.8% arginine, and the same fraction from Walker rat sarcoma 8.0% arginine (*11*).

Green (*2*) extracted ram spermatozoa with dilute acid and alkali, and suggested that the residue was probably the membrane substance. Analysis of the residue showed that it contained no lysine, approximately 23% arginine, and 13% histidine.

The following summarizes the results of rather extensive work by the authors on boar and ram spermatozoa. Most of this work was done on boar spermatozoa.

Our work indicates that neither boar nor ram spermatozoa contain any material soluble in distilled water or 1.0 or 2.0 M NaCl solutions. Grinding of the boar spermatozoa or freezing them to − 40° C, and thawing, did not affect the results with the reagents mentioned. Dilute or concentrated acids, dilute alkalies, detergent solutions, and thioglycollic acid solution extracted only a small amount of material from these cells.

Extraction by stirring for 30 min at room temperature with 1.0 N NaOH, however, removed two protein fractions from boar spermatozoa which precipitate at about pH 6.0 and pH 4.5 respectively. At this point most of the tails and midpieces had disappeared, but the heads retained their shape. The pH 6.0 fraction is so large that it can hardly have come from the tails and midpieces. It contained less than 1% phosphorus. The following amino acids were found in hydrolyzates of this fraction by means of paper chromatography:[2] arginine, lysine, histidine, proline, valine, leucine (isoleucine), phenylalanine, tyrosine, methionine, alanine, threonine, serine, glycine, cystine, glutamic acid, aspartic acid, and two unidentified substances. Microbiological assay[3] showed that tryptophane is also present. A chemical method and a microbiological method both showed the pH 6 fraction to have an arginine content of about 10%.

The smaller pH 4.5 fraction may consist of some of the pH 6.0 fraction, combined with a small amount of nucleic acid.

The residual material left after a half-hour extraction with 1.0 N NaOH contains most of the nucleic acid of the cells. Paper chromatography of hydrolyzates of this material showed the presence of arginine, proline, valine, leucine (isoleucine), phenylalanine, alanine, threonine, serine, glycine, cystine, glutamic acid, and aspartic acid. Microbiological assay indicated that tryptophane is also present. Neither method showed more than traces of methionine, histidine, or lysine. Both chemical and microbiological determinations indicated the presence of a large quantity of arginine. Calculations allowing for the nucleic acid content of this fraction indicated that the arginine content of the protein part is at least 25%.

Allowing this residual material to stand overnight at room temperature with 1.0 N NaOH brings into solution some material which contains protein but is predominantly nucleic acid. The dissolved material precipitates at about pH 2–3 when the solution is acidified. It seems that the long treatment with alkali probably brings about the splitting of a nucleoprotein complex. Practically nothing is brought into solution when the long treatment with alkali is carried out at 5° C. The portion still undissolved after this long alkali treatment contains what appear to be "ghost" heads of spermatozoa and also some fine granular material.

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[1] Contribution from the Department of Agricultural Chemistry, Missouri Agricultural Experiment Stations, Journal Series No. 1157.

[2] The paper chromatography was kindly done for us by Dr. Eugene Roberts, of the Cancer Research Division of the Anatomy Department, Washington University School of Medicine, St. Louis.

[3] We are indebted to Mr. A. Lee Caldwell, of Eli Lilly and Company for the microbiological assays.

Previous work by other investigators and our work would seem to indicate that nuclei, in general, contain the following:

1. Nucleohistones or nucleoprotamines extractable with water or NaCl solutions.

The mammalian spermatozoa so far studied differ from other nucleated cells in containing no substances soluble in water or NaCl. These substances may be present in an altered form with different solubility characteristics.

2. Proteins extractable with alkali and precipitating when the solution is made acid.

The pH 6 fraction from thymus nuclei (Mayer and Gulick) and the pH 6 and 4.5 fractions from boar spermatozoa are protein fractions of this nature. This type of protein can be included only provisionally as a constituent of nuclei in general.

3. A highly insoluble residual material containing proteins and nucleic acids.

Green's residue from ram spermatozoa, the tryptophane-containing protein of Mirsky and Pollister, the "residual chromosome" of Mirsky and Ris, the "chromosomin" of Stedman and Stedman, and our residual material from boar spermatozoa all seem to belong in this category. They are all highly insoluble and require drastic treatment to bring even a part into solution.

A highly significant characteristic of the residue obtained by Green from ram spermatozoa and of our residue from boar spermatozoa is the high arginine content. The absence of lysine from these residues is also of interest.

Davidson and Lawrie recently reported (*1*) the results of amino acid analysis by paper chromatography of histone and residual material from calf thymus, rat liver, and fowl erythrocyte nuclei. These authors noted the absence of lysine in the residual material from all three of these sources. The quantity of arginine present was not reported.

The presence of more than one type of protein in each of these insoluble residues must be considered. The proteins with high arginine content in some of these residues may be, as suggested, altered forms of nucleohistones. On the other hand, the proteins of high arginine content in these residues may represent an entirely different type of protein.

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A Possible Standard for Radioiodine

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Recently a radioactive thallium isotope has been suggested as a standard for comparison with I^{131} (*1*). It seems likely, however, that Cl^{36} will be more satisfactory for the purpose. Its maximum β-energy, 0.66 mev, differs very little from the corresponding value for I^{131}, 0.60 mev. Radioiodine has a second limit of minor importance at about half this value (*3, 4*).

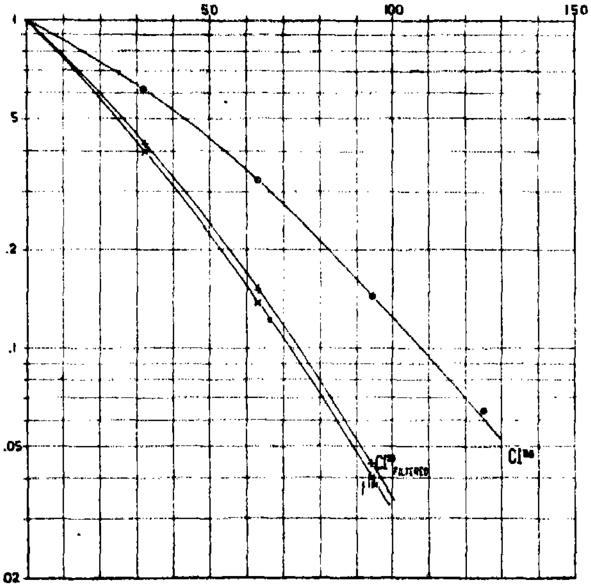

Fig. 1. Absorption of the beta rays of Cl^{36} and I^{131} in aluminum. The curve + + + indicates beta particles already filtered through 125 mg/cm². It is the continuation of the top curve.

The difference between the β energies is, however, sufficient to make the absorption curves quite dissimilar (Fig. 1).[1] As both lines curve downward in the normal way, it is possible to select two parts, one for each line, which have the same direction. Thus the absorption of Cl^{36} β particles, which have passed through 125 mg/cm² of aluminum, coincides almost exactly with the absorption of the unfiltered β radiation of I^{131}.[2] This suggests the use of a preparation containing Cl^{36} covered with 125 mg/cm² of aluminum as a standard for I^{131}. As only weak gamma rays are emitted by Cl^{36} (*2*) there is no objection to the reduction of the intensity caused by this filtering.

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[1] The absorption of the β radiation of Cl^{36} was determined in connection with measurements performed for Mr. C. B. Heyn. The Cl^{36} had been allotted to him for physiological investigations by the Atomic Energy Commission. The radioiodine had been furnished by the Isotope Branch of the Atomic Energy Research Establishment, Harwell.

[2] Radiochlorine had been purified from radiophosphorus and radiosulfur. Further purification caused no change in the absorption curve. The absorption of radioiodine beta rays was checked by comparison with a second preparation, obtained a few weeks earlier.

A Cl^{36} sample, prepared as described, was compared with a radioiodine sample, using different counters which happened to be readily available in our institute. The results are seen in Table 1.

TABLE 1

Counter type	Window thickness mg/cm²	Ratio of cpm with standard and with radioiodine
Tracerlab	2.73 (mica)	1.08
Beta counter	1.5 (mica)	1.06
X ray counter	4.3 (mica)	1.06
Philips Eindhoven	about 80 (steel tube)	1.41

It is seen that the agreement with mica window counters is excellent, and even with a steel tube counter, a type of instrument which will never be chosen for standardizing radioiodine, the agreement is not worse than the average result obtained in different laboratories (*1*). This means that, with our standard, radioiodine samples can be counted under different counting arrangements without corrections.

The standard should not be used at a distance much less than half the diameter of the counter's sensitive surface. Results are best between this distance and twice its value; if larger variations are allowed results tend to be less satisfactory and deviations of about 25% may occur.

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The Inhibition of the Cholinesterase Activity of Human Blood Plasma by Neutral Phosphate Esters. II: Studies with Hexa 1-C^{14}-Ethyl Tetrapolyphosphate[1]

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Compounds containing the grouping P-O-R (R = alkyl or aryl) are potent inhibitors of human plasma cholinesterase if they also include a sterically strained configuration around the phosphorus atom (as in tri *o*-cresyl phosphate), or if that atom participates in an acid anhydride linkage (as in the case of the tetraalykl pryophosphates) (*2*). The reaction between enzyme and inhibitor results in the rapid inactivation not only of the enzyme, but also of the inhibitor. Inactivation of the inhibitor is observed only on reaction with active esterase, and inactivation of the enzyme does not take place if the pyrophosphate linkages of compounds like tetraethyl pyrophosphate have been hydrolyzed by even brief contact of the inhibitor with water. The inhibition of plasma cholinesterase activity by such compounds is not reversed on removal of the inhibitor by hydrolysis and prolonged dialysis.

These observations strongly suggest that the interaction of plasma cholinesterase with such phosphorus compounds results in the formation of rather stable compounds involving the active groupings of the enzyme.

TABLE 1

Specific activity of HETP	7.02 × 10^2 cpm/mM
Activity added as HETP to all preparations	5.74 × 10^3 cpm/mg protein
Activity recovered in protein precipitated after dialysis:	
From active enzyme + intact HETP	8.05 cpm/mg protein
From active enzyme + hydrolyzed HETP	1.43 cpm/mg protein
From denatured enzyme + intact HETP	1.03 cpm/mg protein

In order to further test this hypothesis, hexaethyl tetrapolyphosphate (HETP) containing P^{32} or C^{14} as tracer atom has been prepared. An earlier test employing P^{32} tagged material (*2*) merely demonstrated that less than 1.0% of the HETP added was fixed on the enzyme, suggesting that the anticholinesterase activity of this material might reside in a minor component obtained in the course of preparation; possibly this component could be tetraethyl pyrophosphate (TEPP), the most active member of this group detected so far. The purpose of the present note is to report results obtained under more favorable conditions involving the use of C^{14}-labeled HETP.

The preparation of the inhibitor from P_2O_5 and $P(O)(OC_2H_5)_3$ was carried out as described previously (*2*), except that C^{14}-containing triethyl phosphate, prepared by reacting $CH_3C^{14}H_2I$ with silver phosphate, was employed.[2] The preparation obtained had a specific activity of 3 mc/mM of hexaethyl tetraphosphate. The human plasma esterase preparation employed[3] had a cholinesterase activity of 5.24 M CO_2 evolved/hr/g under standard conditions (0.8 M acetyl choline bromide) (*1*); this preparation is approximately ten times as pure as the fraction IV-6-3 previously employed.

The plan of the experiments, based upon these methods may be seen from Table 1. The following are additional details of preparation: a slight excess of inhibitor, or its equivalent, was added to the enzyme; HETP was hydrolyzed by contact with water (1% solution) for 72 hr; less than 0.1% of the initial anticholinesterase activity remained at this time. Denatured enzyme was prepared by heating the enzyme solution to 80° C for 20 min to complete inactivation; 0.45% concentrations of protein were used in all cases. Dialyses were carried out in a rotating rack against 15 successive changes, at 8-hr intervals of 0.3% NaCl (30 ml per 4 ml enzyme solution each time); no C^{14} could be detected in any dialyzates after the tenth change. Precipitation of the protein from the dialyzed solutions was performed by the addition of five volumes of acetone to one of enzyme solution, after preliminary trial had shown that results obtained by this procedure did not differ from those obtained under the much more elaborate conditions required to obtain a dry precipitate of native protein. For counting, samples weighing 2.8–3.1 mg were collected on filter paper disks of 3.9 cm^2, dried in a vacuum desiccator, and counted directly (2.0 mg/cm^2 end window counter). Since all samples fell within the same narrow and low range of mass thickness, no self-absorption correction was applied. A standard was prepared by combustion of a known weight of HETP, collection of the CO_2 formed as $BaCO_3$, dilution of the activity with a known proportion of $BaCO_3$ in a homogenizer, and counting of a 3.0-mg sample on filter paper.

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[1] Supported by a grant from the Division of Research Grants and Fellowships, U. S. Public Health Service.

[2] This preparation was carried out for this laboratory by Tracerlab, Inc., Boston, Massachusetts.

[3] This material was made available through the kindness of Dr. Surgenor, Department of Physical Chemistry, Harvard Medical School, Boston, Massachusetts.

Three experiments carried out by these procedures yielded results in close agreement. Table 1 shows the averages of the values obtained. Three points are immediately evident from inspection of the figures. There is a definite, measurable uptake of C^{14} by the enzyme on reaction with active inhibitor. There is much less, though yet measurable, protein fixation of C^{14} under conditions which do not result in enzymologically detectable reactions between protein and phosphorus compounds. Only a small fraction of the HETP required to inhibit the enzyme is actually bound by the protein.

From the figures for C^{14} uptake and for the specific activity of the sample of HETP employed, molecular relations can be calculated if the molecular weight of the protein is known. Taking 3×10^5 as, at present, the most likely value for the mean molecular weight of this protein, a figure of 3.45×10^{-2} mol of HETP bound per mol of protein is obtained.

Assuming that inhibition of 1 mol of enzyme involves the firm fixation of 1 mol of inhibitor, these data suggest that the protein preparation employed actually contained about 3% active enzyme. This estimate is in good accord with values derived from other considerations.

The protein-to-inhibitor ratio derived from the fixation of C^{14} is also in good accord with the ratio calculated for TEPP from data on enzyme inhibition. In this case, 50% inhibition of the present enzyme preparation occurs at a ratio of 1.41×10^{-2}M TEPP/M protein, or a calculated uptake for complete inhibition (in view of the linear concentration-inhibition curve [*2*] of 2.82×10^{-2}M TEPP/M protein). This figure is in fair agreement with that calculated above if correction is made for C^{14} uptake that does not appear related to the enzyme-inhibitor reaction.

The data presented indicate the formation of a stable compound between plasma cholinesterase and a small fraction of the hexaethyl tetrapolyphosphate required to inhibit the enzyme. From 82 to 88% of the C^{14} fixation thus obtained appears to be related to the enzyme inhibition, the rest being accounted for by a much less specific reaction. Calculations have been presented indicating that the amount of C^{14} taken up in connection with the specific reaction is close to the amount of tetraethyl pyrophosphate required for complete inhibition of the enzyme, again suggesting that the anticholinesterase activity may reside in this or closely similar compounds of this group. Finally, an estimate of the molecular relations between HETP and the enzyme has been presented; a reasonable value (about 3%) for the purity of the enzyme preparation employed could be arrived at on the assumption of a mean molecular weight of 3×10^5 for the protein, and of a reaction involving 1 mol of HETP and 1 mol of protein.

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Iron Metabolism.[1] Heme Synthesis *in Vitro* by Immature Erythrocytes

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Studies with radioiron have indicated that there is no exchange of iron between the mature erythrocyte and surrounding plasma (*3, 4*). The following data, however, indicate that reticulocytes will assimilate iron and synthesize heme *in vitro*, and that this uptake of radioiron may be used as an indicator of the rate of hemoglobin synthesis.

Fe^{59} and Fe^{55} with specific activity of about 20 and 200 μc/mg iron respectively were prepared at the Massachusetts Institute of Technology cyclotron. Blood with an increased content of reticulocytes from patients with pernicious anemia during a response to liver and from patients with iron deficiency, and bone marrow from rats and humans were used. *In vitro* studies were performed in rocking boats at 37° C in a gas mixture of 95% oxygen and 5% CO_2, as previously described by Geiman and his associates (*2*), over a period from 4 to 24 hr. Those experiments extending beyond 6 hr were carried out with sterile precautions.

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[1] Assisted by the joint program of the Office of Naval Research, the Atomic Energy Commission, by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service and, in part, through support from Smith, Kline, and French.

While blood containing less than 1% reticulocytes took up no measureable quantity of radioiron, uptake of radioactivity was demonstrated repeatedly in blood with a high reticulocyte content. That the radioactivity was localized in the immature cell population was shown by correlation of the reticulocyte count and radioactivity in various fractions of this blood separated by the albumin flotation technique (*7*).

TABLE 1

	Reticulocytes	Cpm/ml red cells
Top (low cell specific gravity)	53%	500
Bottom (high cell specific gravity)	5%	35

Table 1 shows such a separation of whole blood previously incubated for 4 hr with radioiron, washed five times in ten times its volume of 1% saline, and then partitioned by albumin flotation.

Various types of blood were studied, including iron-deficiency anemia, acquired hemolytic anemia, sickle cell anemia, and pernicious anemia. The uptake of iron in all instances was attributable to the presence of reticulocytes. It would further appear that in pernicious anemia at least the rate of uptake is also related to the type of reticulocyte present. The early reticulocytes after liver therapy contain more reticular material and pick up more radioactivity, as shown in Fig. 1.

Conditions necessary for the uptake of radioiron have been studied to a limited degree. Ferrous iron added to a saline suspension of erythrocytes containing an increased number of reticulocytes is taken up perhaps twice as rapidly as ferric iron. Iron carried by the iron-binding protein of the serum (*5*) *is assimilated* by the reticulocyte but less rapidly than the inorganic ferrous and ferric iron. The iron uptake is impaired by lack of glucose in the media and by low temperature. In an effort to determine whether the uptake of iron indicated hemoglobin formation, red cells have been fractionated after incubation with radioiron. The largest amount of activity in the reticulocyte portion was found in the stroma of the hemolyzed cells. However, significant amounts of radioiron were also demonstrated in recrystallized heme from those cells. These observations indicate that the physiological process of the assimilation of iron by the developing red cell is, first, the attachment of iron to acceptors in the red cell stroma capable of removing iron from the serum and second, the synthesis of heme. These studies also indicate that reticulocytes are still capable of completing the process of hemoglobinization in the peripheral blood, in keeping with observations that tagged reticulocytes live a normal life span (*1*).

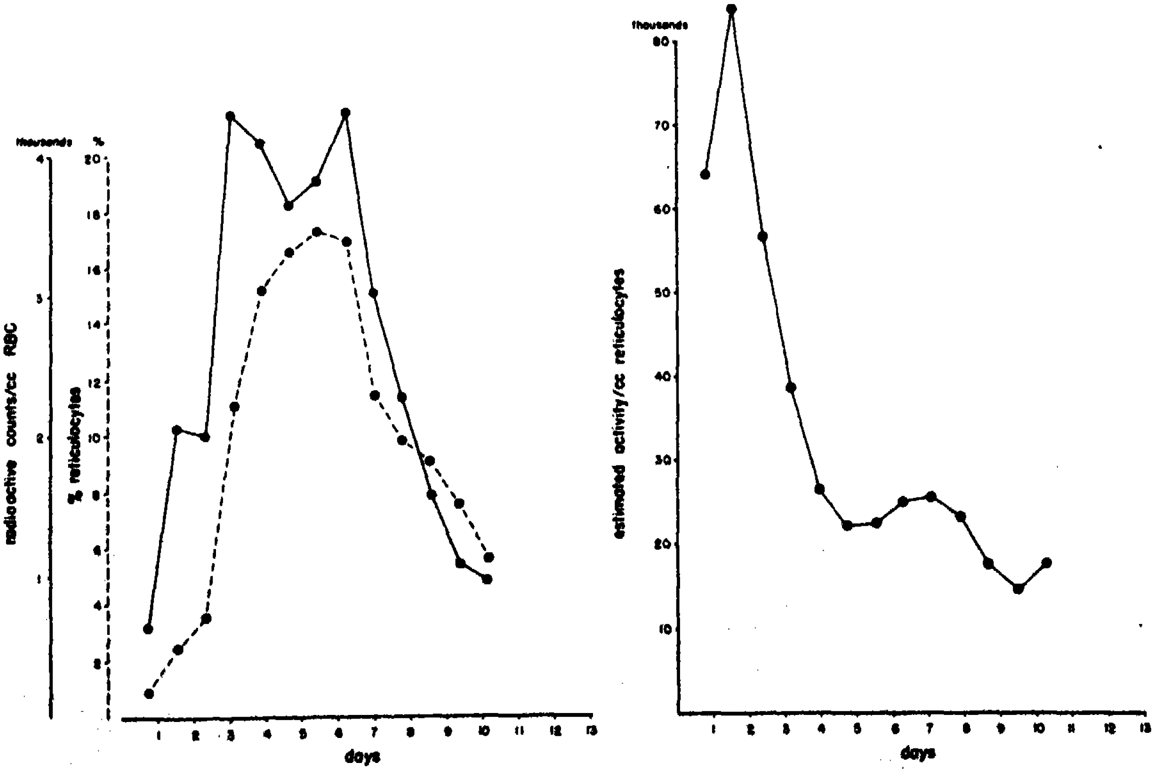

FIG. 1. Incubation of blood with radioiron *in vitro*. The patient studied had pernicious anemia and was given 60 units of liver concentrate on 0 day. On each subsequent day 20 ml of blood was drawn and incubated with radioiron over a period of 6 hr. The % reticulocytes and uptake of radioiron per ml of blood and per ml reticulocytes are shown above. It is assumed in the calculation of activity per ml reticulocytes that only reticulocytes take up radioiron.

The dotted line in the figure indicates % reticulocytes; the solid line indicates radioactive counts.

Similar incubation studies have been conducted on bone marrow aspirations. As might be expected from the spectrophotometric studies of Thorell relating to hemoglobin synthesis (*6*), the uptake of radioiron by normoblasts is much greater than that observed in reticulocytes. Again, radioactive heme could be demonstrated after incubation of radioiron with these marrow cells.

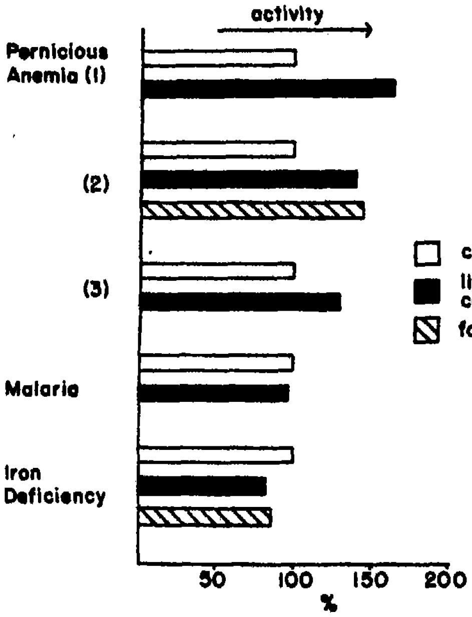

FIG. 2. Marrow incubation. Effect of folic acid and liver. Marrow cells obtained by sternal aspiration from patients with untreated pernicious anemia showed an increase in radioiron uptake of 66%, 44%, and 28% after addition of liver (1×10^{-4} unit) or folic acid (5 μg). This was in contrast to slight decreases found in other conditions not involving a deficiency in these substances.

It is possible to use radioiron as an indicator of altered hematopoiesis, as shown in Fig. 2. Suspensions of marrow from patients with untreated pernicious anemia have repeatedly shown an acceleration of the rate of iron uptake after the addition of liver or folic acid as compared with control studies. This has not occurred in conditions other than those characterized by specific deficiencies of the substances used. These observations on the marrow cells in untreated pernicious anemia indicate that these effective therapeutic agents act directly on the immature erythrocytes.

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Freezing of Whole Blood

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It is a generally accepted hypothesis that freezing and thawing of red cells results in hemolysis. Alternate freezing and thawing is a procedure commonly employed in the laboratory for the purpose of obtaining hemolysis. Preliminary experiments carried out in 1942 showed that the hypothesis is not correct under all conditions, i.e., it is possible to freeze whole blood in a solid mass and thaw it without appreciable hemolysis. "Freezing of blood" is here intended to mean solidification of blood by means of temperatures well below the freezing point of blood.

Early in our experiments, evidence showed that the type of water crystallization resulting from freezing was not an essential factor in the behavior of the red cells. Thus, equally good preservation of red cells was obtained by slow freezing at − 3° C or by very rapid freezing at − 60° C. In the case of slow freezing, the mass of frozen blood showed formation of large crystals; whereas with fast freezing, the mass of frozen blood appeared very uniform. Fast freezing was carried out as follows: 1 ml of whole human blood collected in an acid-citrate-dextrose mixture was placed in a glass test tube. The blood was frozen by manually rotating the tube in cracked CO_2 ice. Freezing occurred in a few seconds, and the tube containing the solid blood was removed instantly upon solidification and placed in the water bath at 37° C to thaw with the aid of agitation. The hematocrit before freezing was 39.37; after freezing and thawing, 39.07; the supernatant fluid showed no appreciable discoloration from hemoglobin. However, if frozen blood was allowed to remain in contact with CO_2 ice for even a few seconds after freezing, massive hemolysis resulted upon thawing.

Experiments on freezing of whole blood were resumed about a year ago. More than 150 specimens of blood have been frozen and thawed under varying conditions of temperature, heat dissipation (affecting the time of freezing), concentration of electrolytes, pH, concentration of diffusible and nondiffusible sugars (affecting the size of the erythrocytes), etc. In a series of a little over 100 specimens of blood, freezing and thawing were accomplished with a resulting hemolysis of less than 1% of the cells. Most of these specimens were collected in an acid citrate solution, with and without glucose. In these experiments the hematocrit was determined with the use of an air turbine (*2*) and the osmotic fragility by the method proposed by Parpart (*3*). The concentration of hemoglobin in the supernatant plasma was measured by the method of Karr and Chornock (*1*).

It is of practical importance to note that even when freezing and thawing of red cells at − 3° C results in some hemolysis, the remaining red cells appear to be undamaged.

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[1] With the technical assistance of Miss Margaret M. Dolan and Miss Louise Colwell.

Experiments have shown that regardless of the mode of freezing of blood, rapid thawing at +37° C in the water bath with agitation is the best method to avoid hemolysis. Results similar to those reported for whole citrated blood may be expected, and have been obtained, with red cells suspended in various media. Much better results have been obtained when red cells are frozen after crenation produced by a hypertonic solution of sucrose, than when red cells are swollen by the addition of a hypotonic solution of glucose.

The preservation of blood in the frozen state is of particular interest for the obvious practical advantages which it offers. In all, about 100 specimens of blood have been satisfactorily preserved for varying periods of time up to 1 month.

The importance of temperature control for proper preservation of blood in the frozen state is best emphasized by the following experiment: 500 ml of whole blood were mixed with 75 ml of chilled anticoagulant solution.[3] Blood was maintained at room temperature for the first 3 hr. It was then distributed in 10-ml aliquots in rubber stoppered, thin-walled test tubes. A tube (#8) was placed in a rapidly circulating water-alcohol mixture cooled to −14° C. The blood in the tube was agitated and the thermometric readings were as follows:

Time (min)	Temperature (° C)
0	+21
1	+ 6
2	+ 1
3	± 0
4	− 1
5	− 2.4
6	− 0.455

Initial freezing occurred at this point, and the tube was allowed to remain in the cooled bath for an additional 14 sec. While the thermometer still registered about −0.455° C, the tube of semifrozen blood was removed and placed at −3° C in an air cabinet. Within a few minutes at this temperature the blood became completely solid, and was maintained solid at −3° C for 1 hr.

Tube #3 was treated in a similar manner, but after initial freezing at about −0.5° C, the tube was maintained at −14° C for a little over 3 min; this tube then was also placed at −3° C and maintained in the solid state for 1 hr.

A control tube (C) contained whole blood preserved in A.C.D. solution and maintained at +4° C for about 4 days.

Results of hematocrit determinations, and of determinations of hemoglobin in the supernatant fluid, and of osmotic fragility in hypotonic salt solution after thawing are shown in the table and figure.

The results may be summarized as follows: When whole citrated blood is frozen to a solid mass in a cooled circulation bath, removed as soon as freezing has started and placed at −3° C (+0.5) for periods of several hours, minimal hemolysis and minimal changes in the hematocrit and osmotic resistance are noted comparable to that obtained with whole blood preserved in A.C.D. solution at +4° C for 4 days. When frozen blood is allowed to cool for even a very short period of time at temperatures below −3° C, rapid and severe hemolysis occurs.

TABLE 1

HEMATOCRIT READING AND HEMOGLOBIN OF SUPERNATANT PLASMA OF WHOLE BLOOD FROZEN AND PRESERVED FOR 1 HR AT −3° C IN THE FROZEN STATE

	Hematocrit readings	Hemoglobin in supernatant plasma
Control	36.61	3 mg %
Tube #8[*]	36.84	6 mg %
Tube #3[†]	30.40	240 mg %

[*] Tube #8 was properly frozen and thawed.

[†] Tube #3 was allowed to remain too long after initiation of freezing in the bath at −14° C. The discrepancy between the hemoglobin in the supernatant plasma and the hematocrit reading is due to the fact that high centrifugal force, developed in the air turbine used for hematocrit determinations, breaks damaged red cells. This discrepancy is always an indication of poor preservation of red cells. The hematocrit of damaged cells is generally difficult to determine and not too reliable.

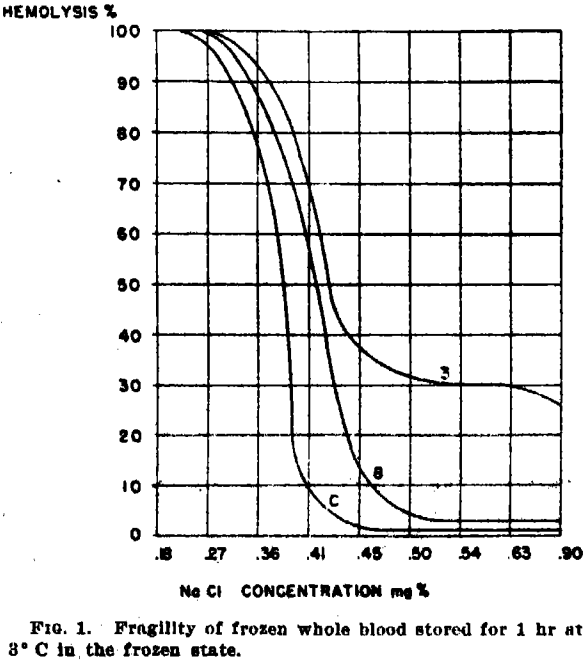

FIG. 1. Fragility of frozen whole blood stored for 1 hr at 3° C in the frozen state.

When whole citrated blood is placed in an air cabinet, cooled at −3° C and allowed to remain undisturbed, it will remain liquid for an indefinite period of time. This has allowed comparative study of blood preserved at −3° C in the solid and in the liquid states.

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[3] Standard A.C.D.

The results obtained so far in the preservation of frozen and liquid blood at −3° C are sufficiently encouraging to justify further studies, which are now under way.

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A "Free Manometer" Method of Using the Standard Warburg Apparatus[1]

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In the Warburg apparatus, as commonly employed, a gas reaction occurs within a closed system of constant volume. The temperature being held constant, pressure changes (read on the open manometer arm) are related by a linear function to the volume of gas evolved or taken up. This function is known as the "vessel constant" and depends upon gas-space volume, fluid volume, temperature, solubility of the reacting gas, atmospheric pressure, and manometer fluid density (*1*).

It can be shown that within the limits of accuracy generally accepted in the Warburg technique (±1%), a constant volume is not in fact required; that if both pressure and volume are permitted to vary, a linear function (vessel constant) is still obtained; and that consequently the repeated leveling of manometer fluid, whereby a constant volume is maintained, can be eliminated.

The free manometer technique presents the following unique features: automatic recording, by a time-controlled camera, becomes feasible; certain small errors inherent in the process of leveling the manometer fluid are eliminated; readings can be made more rapidly, more frequently, and with greater ease, and arithmetical steps are greatly simplified; the capacity of the standard manometer is substantially increased, while its sensitivity is correspondingly reduced. A total gas change three to four times as great as by the constant volume method can be measured without resetting the manometer. This increased capacity has been found desirable in at least two applications: in measuring substrate oxidation by cells or tissues in the face of a high endogenous rate, and in studying the protracted time course of enzyme-substrate reactions.

The fluid on the vessel side of the manometer is set initially to the manometer midpoint and subsequent readings are made on this same arm of the manometer. The fluid adjustment is not touched again after the initial setting. A reciprocal and equal change occurs in the fluid levels of the two arms as a reaction proceeds, but the fluid in the open arm is ignored. Thermobarometer corrections, provided they are not exceedingly large (< 5 mm), are made in the usual fashion, but the thermobarometer vessel must contain the same volume of fluid as the other vessels.

If the vessel constants are determined empirically no special problems arise. If they are calculated from mercury calibration of the gas space an additional factor M is required. M is the linear volume of the manometer (cu mm/mm) and is obtained automatically if one follows the calibration method suggested by Burris (*3*, p. 50), filling the manometer first to a point above, and then to a point below the midpoint mark. The full vessel constant equation is:[2]

$$k = \left[\frac{V P_0 + V_f RT\alpha_x}{P_0 RT}\right]\left[\frac{p_x P_0 M}{V P_0 + V_f RT\alpha_x} + \frac{p_z P_0 M}{V P_0 + V_f RT\alpha_z} + 2\right]$$

It should be noted that the only variables requiring calibration are V and M. The observed change in level (mm) on one arm of the manometer multiplied by the vessel constant gives moles of gas reacting at NTP.

The full equation must be used for CO_2, but O_2 and other gases of low solubility can be determined with the following simplified vessel constant:

$$k = \frac{2V + M\,(P_0 - p_w)}{RT} + V_f\,\alpha_x\left[\frac{2V + M\,(P_0 - p_w)}{V P_0}\right]$$

where p_w is the vapor pressure of water (mm manometer fluid) at temperature T.

The method described here has been in use in this laboratory for some time. Replicate determinations of CO_2 and O_2 by free manometer and constant volume techniques under diverse conditions agree satisfactorily. It has proved convenient to calculate vessel constants by both methods and to use the free manometer technique routinely, reserving the constant volume technique for those occasions when high sensitivity is desired. Full theoretical and practical details of the method will be published elsewhere (*2*).

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[1] The work reported in this paper was done during tenure of a Lalor Fellowship and was also supported by a grant from the Abbott Laboratories, North Chicago, Illinois.

[2] V = gas space (cu mm)
M = manometer factor (cu mm/mm)
$R = 8.21 \times 10^4 \times P_0$
T = absolute temperature
p_x = initial partial pressure of reacting gas (mm manometer fluid)
p_z = initial partial pressure of inert gas (mm manometer fluid)
P_0 = atmospheric pressure (mm manometer fluid)
V_f = fluid volume (cu mm)
α_x, α_z = solubility coefficients of the gases (moles/cu mm at P_0, T)

A Method of Optically Recording Contractions and Electrocardiograms from Isolated Frog Hearts

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Duke University School of Medicine,
Durham, North Carolina

This method was devised for recording simultaneously the muscular contractions and electrocardiograms from the isolated frog heart. The apparatus consists of a glass tube, 15-mm bore and 6–7 cm long, with two short side arms about 1 cm from the top and bottom, respectively, of the tube. The bottom is sealed by a rubber stopper through which projects a small glass tube containing an electrode projecting into the tube and which is vertically adjustable within the tube. The lower side arm is connected by rubber tubing with a small leveling bulb, which is filled half-full with the control solution used for perfusion (e.g., Ringer's or Clark's). This bulb is convenient for adjusting the fluid level in the tube, which is filled about half-full with the solution.

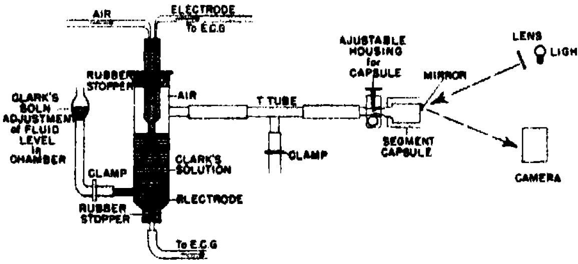

FIG. 1. Diagram of apparatus.

The heart is perfused by the method of Straub. The perfusion cannula bearing the frog heart passes through a rubber stopper of proper size to close the top of the tube. The heart is then put in the tube, and the cannula adjusted so that the heart is just immersed in the control solution. The tube thus becomes a modified cardiometer. The upper side arm is connected by a short piece of 2-mm bore rubber tubing bearing a T tube to equalize pressure, with a Wiggers (*1*) segment capsule. The capsule is covered by a moderately stretched condom diaphragm which carries the mirror. The second electrocardiographic electrode consists of a German silver wire about 18 gage which is passed down inside the perfusion cannula so that its tip is just above the constriction of the cannula. The perfusing solution, and the control solution in which the heart is immersed, adequately serve as conductors. A diagram of the apparatus appears in Fig. 1.

A variant of this procedure consists in attaching the tip of the ventricle by means of a clip and fine wire conductor to a small flat tambour loosely covered by a condom diaphragm. The wire is attached to the center of the tambour diaphragm so that a very slight tension is maintained on the heart. One electrode is then connected with this wire. The tambour outlet is then connected with the segment capsule as above. No solution surrounds the heart in this case. This method was found to be inadequate to record feeble contractions.

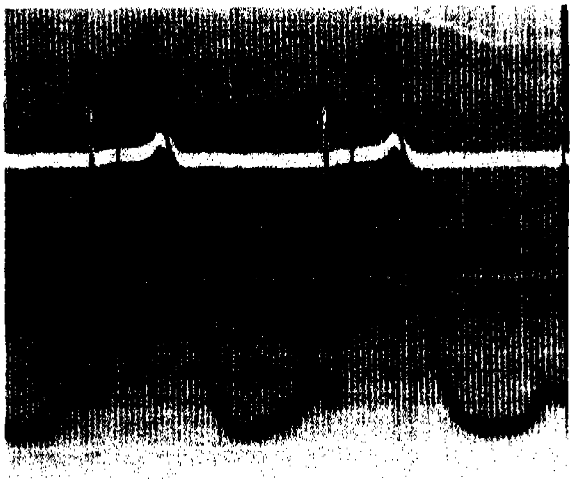

FIG. 2. Electrocardiogram and cardiometer curves. *T* and *P* waves show as small deflections. *A* and *V* indicate auricular and ventricular volume changes.

The cardiometer in our experience has proved to be adequate to record any visible contraction. It affords much greater flexibility, and the sensitivity of the recording apparatus may be easily and rapidly altered by varying the volume of air above the fluid. We have found some 5 cm^3 of air in the tube a convenient volume to secure regularly an excursion of 8–10 cm from normal frog hearts.

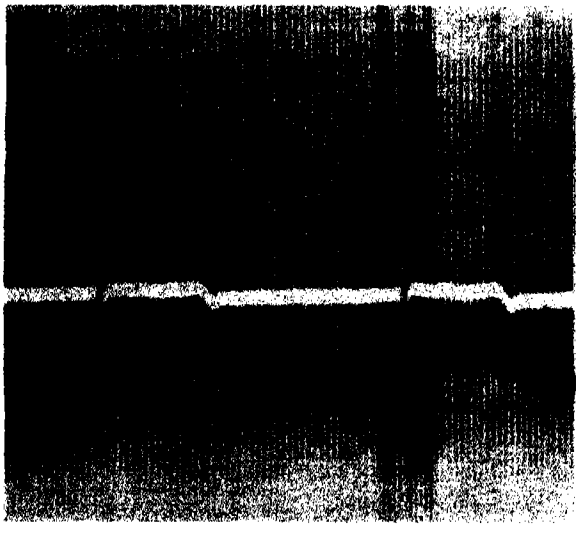

FIG. 3. Above—Electrocardiogram. Below—ventricular myogram.

Fig. 2 was obtained using the first method described. Fig. 3 was obtained by the second method.

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Hydrolysis of Adenosine Triphosphate by Trichloracetic Acid[1]

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New York City

In the determination of adenosine triphosphatase activity, the usual procedure utilizes addition of trichloracetic acid for precipitation of the protein and stopping of the enzyme action. The estimation of inorganic phosphorus is then done on the filtrate. In determining dephosphorylation of an adenosine triphosphate substrate by human serum (*2*), we had occasion to leave the trichloracetic acid filtrates overnight in the icebox. Subsequent estimations of these same filtrates for inorganic phosphorus revealed values which were much higher than those previously obtained. Our interest in this casual observation led us to undertake an investigation of this phenomenon.

Experimentally, a solution of sodium adenosine triphosphate[2] in veronal-HCl buffer at pH 8.9, in a concentration of 1 mg in 1 ml of buffer was used. Filtrates were prepared in the following manner: to each 2.5-ml portion of the buffered Na-ATP solution 0.5 ml of water (instead of serum) and 5 ml of 8% trichloracetic acid was added, and the resulting solution was well mixed and then filtered. The inorganic phosphorus was determined on 4 ml of the filtrate by the method of Fiske and Subbarow (*1*). Sufficient filtrate was made to insure duplicate estimations of inorganic phosphorus at the end of the various time periods. The results are recorded in Table 1.

TABLE 1

HYDROLYSIS OF NA-ATP BY TRICHLORACETIC ACID

Sample	Preparation	Control	Time in hr		
			2	4	24
		µg P/ml			
1	Na-ATP 1 mg in 1 ml of veronal-HCl buffer, pH 8.9, room temperature	4.1	6.3	8.1	27.3
2	Do., in icebox	4.1	5.1	5.8	10.3
3	Na-ATP 1 mg in 1 ml H_2O, room temperature	4.4	5.5	7.9	
4	Do.	2.4	6.8	8.4	

In order to obviate the possible effect of the buffer solution employed, an aqueous solution of Na-ATP in the same concentration was prepared and treated in the same manner as described above. These results are also shown in Table 1.

It is evident that there is a definite increase in inorganic phosphorus when adenosine triphosphate in trichloracetic acid is allowed to stand at either room or icebox temperature. No such change takes place when solutions of adenosine triphosphate without addition of trichloracetic acid are allowed to remain for the same periods of time. Trichloracetic acid filtrates prepared from serum alone do not hydrolyze under similar conditions of time and temperature.

The results indicate that spontaneous hydrolysis of adenosine triphosphate by trichloracetic acid does occur. It is essential that determinations of inorganic phosphorus be made under identical conditions in order to avoid errors due to such hydrolysis.

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[1] Aided by a grant from the Frederick Kolb Fund.

[2] The tetra sodium salt of adenosine triphosphate · $3H_2O$ was obtained from Rohm & Haas, Philadelphia, Pennsylvania.

Differentiation of Aragonite from Calcite by Differential Thermal Analysis

George T. Faust

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I have been making differential thermal analysis studies of carbonate minerals since 1942. Some results of the application of these studies to problems in petrography and mineralogy have been published (*2, 4*). The detailed thermal analysis studies on these minerals are now being prepared for publication. In view of the current interest in differential thermal analysis studies, it seems desirable to put on record an observation, made several years ago, on the identification of aragonite by this method.

The differential thermal analysis apparatus used in these studies is almost identical with the one designed by Hendricks, Alexander, and Nelson (*1, 5*), and with a sensitivity dependent on resistance in series with the galvanometer of 999.9 ohms.

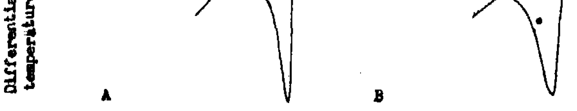

FIG. 1. (A) Calcite from Joplin, Missouri. (B) Aragonite from Chile.

Typical curves for aragonite and calcite are given in Fig. 1. The short diagonal lines are portions of the curve used to determine the temperature of the thermal reactions recorded (*3*). The principal curve shows the course of the thermal reactions.

The calcite sample, illustrated in Fig. 1A, is from Joplin, Missouri, and is part of the tube sample analysed by R. C. Wells (*6*). The curve shows one large peak representing the dissociation of calcium carbonate into calcium oxide and carbon dioxide. The peak temperature for this sample is 972° C. The aragonite (U.S.N.M.-R2554) is from Chile, exact locality unknown, and its thermal curve is shown in Fig. 1B. This curve shows a small peak at 447° C which represents the dimorphic transformation of aragonite to calcite. This transformation of a metastable material is irreversible, and hence does not take place at a reproducible temperature. Subsequently, the calcite, paramorphous after aragonite, undergoes decomposition at 897° C. The temperature of the dissociation of calcite is not a definite temperature in a nonequilibrium process. The presence of the low temperature peak, in this sample of aragonite at 447° C, representing the transformation of aragonite to calcite, serves to differentiate these two minerals. However, this peak requires a sensitive, continuous recording apparatus and can easily be overlooked.

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[1] Published by permission of the Director, U. S. Geological Survey, Washington, D. C.

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Comments and Communications

The Preparation of Graphs for Publication

In the preparation of graphs of many sorts, it is exceedingly convenient to use graph paper. Graphs so prepared are satisfactory for study but not for publication, because of the background of fine lines. If blue-lined paper has been used, these lines can be eliminated by photography; but this requires some experience and skill and, for some of us, is apt to mean more than one attempt. Moreover, blue-lined paper is not always available.

Recently I noticed that the lines on graph paper show through the paper well enough for the fixing of points on the back. The graph paper is placed upside down on a white surface, and the portion of the sheet to be used is outlined and certain reference points are indicated before the data points are marked. The finished graph, in ink on the plain white back of the paper, may be submitted directly or conveniently photographed.

This method may be helpful to many investigators where professional draftsmen are not available.

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Use of Omental Spread in Biological and Pathological Studies

The advantages of using the omentum of a small animal for making spread preparations instead of attempting to section the tissue have been pointed out by Cross (*Science*, 1949, **109**, 314). However, the technique described, of first taking up the desired portion of omentum on a bit of cigarette paper and then transferring it to a slide, is needlessly complicated. Instead, a piece of omentum may be removed and placed directly on a slide (Woodruff, C. E. *Amer. J. Path.*, 1934, **10**, 739). Then, making use of the property of this thin membrane of fixing itself to glass, one corner of the omentum may be teased out and allowed to dry on the slide. From this anchoring corner the balance of the membrane may be teased out to form a thin layer most of which will be only one cell thick. Certain stains such as the Ziehl-Neelson may be used on the omental spread without further fixation. Other stains may require the use of formalin or some other fixative prior to staining. The stained preparation is readily mounted in balsam and affords a three-dimensional picture of developing disease processes which one cannot obtain by the use of conventional histological sections.

Very satisfactory omental spreads may be obtained from mice and guinea pigs. The omenta of rabbits and dogs are of less value for this purpose, since the tissue fails to become fixed to the slide in a satisfactory manner.

C. EUGENE WOODRUFF

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Northville, Michigan

Calibration of Warburg Manometers

The paper by Loomis (*Science*, 1949, **109**, 491) concerning the calibration of Warburg manometers omits mention of the convenient method of Schales (*Arch. Biochem.*, 1944, **3**, 475), which also involves the principle of filling the manometers from below by means of a mercury reservoir. Schales' method possesses the further advantage of not requiring any spatial manipulation of the manometers in order to adjust the level of the mercury.

The disadvantage of Schales' method, in our experience, has been the difficulty of placing just the right amount of mercury in the flask in order that the fluid will rise to the point of junction of the side arm and the manometer when the flask is slipped on the ground joint. We have avoided this difficulty by placing a minimum amount of mercury in the flask (usually to the lower edge of the ground surface), and adding further amounts through the gas outlet tube with a capillary pipette after the flask is attached to the manometer. The gas outlet tube is closed to the flask as it is filled with mercury; a small pressure bulb is attached to the tube, and it is rotated so as to be open to the flask. The mercury is gently blown into the flask, thus filling the side arm. This operation is repeated as often as necessary and takes only a few seconds.

This refinement of Schales' procedure eliminates the necessity for spilling even a drop of mercury.

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Correction

Referring to my paper "Microcrystallographic Data on Sodium-D-Glutamate (Monosodium Glutamate)", *Science*, 1949, 110, 304, Dr. B. F. Buchanan, International Minerals & Chemical Corporation, Chicago, informs me that the monosodium glutamate upon which this study was made is the L-form and should be designated as sodium-L-glutamate, being the monohydrate with the following empirical formula: $C_5H_8O_4NNa \cdot H_2O$.

GEORGE L. KEENAN

Strongsville, Ohio

Oral Stress and Meaning in Printed Material

In experiments conducted by the writers, evidence has been secured indicating that the ability of the subject to understand a prose passage may be given in quantitative terms by noting which words the subject stresses as important when he reads the passage aloud.

This apparently novel observation, so far as measurement is concerned, reinforces a belief which many teachers of reading hold, that certain assets have been sacrificed in the current emphasis on silent reading as contrasted with the older oral reading methods. Our conclusion was developed in relation to experiments on the electrical recording of eye movements during long-continued reading of prose set in type forms arranged to emphasize certain ideas.

In the printed material so far studied, words which should be stressed are defined as those words which the author or competent judges stress when they read the material aloud. It has been discovered that readers who stress words which the author indicates should be stressed obtain significantly superior scores when given a written comprehension test on the same reading material. The association between a subject's ability to differentiate between delicate levels of stress and his comprehension of the material read is marked. Correlation coefficients ranging from 0.45 to 0.65 have been consistently found in several hundred high school and college subjects so far studied.

It is not necessary for subjects to read aloud to demonstrate the association between stress and meaning. It is enough that subjects be instructed to mark those words that they would stress were they reading the material in question aloud. The determination of which words the subject would stress can be made conveniently by presenting the subject with a multiple-choice test.

That the *manner* in which a passage is read is correlated substantially with understanding of the passage has implications with respect to methods of teaching reading at the primary grade levels. This finding suggests that more emphasis on oral reading than has recently been recommended may be appropriate.

This relationship between oral stress and meaning is important in considering the possibility of improving the efficiency of print as a transmission system. Attempts have been made down through the years to introduce bold-faced type or italics and to spread out letters as means of indicating stress. Aesthetic and other arguments have been used by those who oppose the use of such varied type. It is clear, however, that vocal stress supplies the listener with information over and above the information which he would receive if speech were conducted exclusively in monotones and at an unchanging rate. It appears a matter for regret that this added oral meaning has not yet been introduced into print in a form which is acceptable. The results of the present experiment suggest that the opposition to the use of varied type has less weight now that there is available a working principle such as is here presented for indicating *consistently* which words or phrases should be stressed.

Our study so far indicates that when a reader wishes to glean the last bit of meaning from a written document he prefers stress indications in the printed matter if he is offered a choice between stressed material and the conventional unstressed material. As an illustration, a group of students who were to be examined in part upon the lectures previously given by a college instructor were offered a choice between a set of notes in standard type or a set of notes arranged so that the print showed the actual vocal stresses which the instructor employed when delivering the lectures. A majority of students preferred the notes printed so as to indicate oral stress. There are other situations where exact understanding is of such critical importance that readers prefer stresses to be shown in the printed documents. Some military orders and directives, for example, fall in this category.

The discovery of the relatively high correlation between the ability to understand and the ability to indicate stressed words, as outlined in this note, is being used in further experiments by the authors on changing the readability of prose. It is anticipated that this less ambiguous system for the transmission of meaning in print will result in decreasing significantly the number and duration of fixation pauses and movements of the eye which are ordinarily required in reading. These experiments are being conducted with due consideration for the aesthetics of the printed page and for modern typographic conventions.

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Book Reviews

Solid analytic geometry. Adrian Albert. New York: McGraw-Hill, 1949. Pp. ix + 162. $3.00.

The first five chapters of this textbook present the usual material on lines, planes, spheres, and the other quadric surfaces, concluding with an invariantive classification of quadrics. The concepts and terminology of vector algebra are introduced immediately and are used effectively throughout. The sixth chapter is devoted to the theory of matrices, which in the seventh chaper is applied to rotations in space and to the principal axis transformation. The last two chapters are considered by the author to be supplementary to a basic course. Chapter 8 is on spherical coordinates and gnomonic charts, useful material which is frequently neglected. Chapter 9 is an introduction to analytic projective geometry in the plane and in space, carried far enough to include a proof by means of matrices of the invariance of the cross ratio.

The treatment throughout is designed to tie analytic geometry to the modern theory of vectors and matrices, and the methods employed are for the most part those which can be generalized directly to the Euclidean geometry of *n* dimensions. The book contains much excellent material illustrating the applications of the theory of vectors and matrices to solid Euclidean geometry and many short and elegant proofs are developed in this technique. The only criticism which occurs to the reviewer is that the viewpoint is predominantly algebraic rather than geometric, and that there is a minimum of emphasis on developing the student's space intuitions.

C. C. MacDuffee

University of Wisconsin

Lehrbuch der Embryologie. Walter Brandt. Basle, Switzerland: S. Karger, 1949. Pp. xii + 648. (Illustrated.) 56 Swiss francs.

This is a textbook of human embryology for medical students. In general, it follows the standard pattern: a rather extensive chapter on general embryology is followed by chapters on organogenesis. The text is written clearly and concisely, and the important chapters on human placentation, fetal circulation, and hormonal control of the sexual cycles, in which fields much recent work has been done, are up to date. The illustrations, partly in color, are adequate for the most part but do not do justice to the chapters on the nervous system and the sense organs. For instance, illustrations of the histogenesis of the central nervous system and of the structural differentiation of the eye and ear and their auxiliary structures are entirely missing. Moreover, illustrations of such important processes as fertilization and gametogenesis (which latter is represented by a poor diagram) would have been desirable.

An innovation of the book is the inclusion of a considerable amount of experimental embryological material. This reviewer is wholeheartedly in favor of a more analytical and dynamic approach to embryology than is offered by most texts. It is, therefore, regrettable that these parts do not live up to expectation. The promise of the author, in the foreword, to incorporate the newest results in developmental physiology is not kept in the text which, apart from very few exceptions, considers the literature only up to 1934. As a result, the presentation of the subject and the viewpoints are outdated and inadequate in many respects. For instance, our conceptions of embryonic induction and of axis determination in limb primordia have undergone considerable changes in the last fifteen years. The old ghosts of mosaic- and regulation-eggs are revived, and the descriptions of gastrulation in Amphibia and in higher forms, and of the fundamental processes of the segregation of organ primordia from the germ layers, are incorrect. In the part on organogenesis, the experimental data on the determination of an organ are presented in advance of the description of its embryonic development; the didactic wisdom of this procedure is questionable. A serious shortcoming of the book is the lack of a bibliography, in spite of numerous bibliographic references in the text. It is of great importance that the attention of the premedical and medical students be directed to sources.

Viktor Hamburger

Washington University

Die Optik in der Feinmesstechnik. (Optics in precision measurements practice.) Kurt Räntsch. Munich, Germany: Carl Hanser, 1949. Pp. 317. (Illustrated.) Cardboard: 27 DM; clothbound: 30 DM.

Here is a valuable contribution to that division of optical engineering which deals with the use of optical instruments for precision measurements. The first third of the book treats in a very thorough manner those principles of geometrical and physical optics which are necessary to provide a background for the intelligent use of precision optical measuring equipment. The paraxial imaging properties of lenses and mirrors are developed systematically. Considerable attention is devoted to apertures and pupils, and to the transmission of flux through a system. The short section on physical optics covers pertinent topics such as interference and diffraction, resolving power, and light losses by reflection. Possibly some readers would have welcomed a brief mention of polarized light, and of optical interference films for antireflection and beam-dividing purposes. There is a convenient eight-page collection of all mathematical formulas at the end of the book for quick reference.

The remaining two-thirds of the book takes up optical instruments. It is replete with good photographs of an astonishing variety of products of the firms of Ernst Leitz and Carl Zeiss. The author, who is a member of the Zeiss organization, explains that this limitation to German manufacturers was necessary under present conditions in order not to delay publication. It is to be hoped that his intention to add instruments of other origin in future editions will materialize. The pictorial representation of the subject matter has been carried out so carefully and completely that it should serve to compensate the language difficulties which some may have, the book being, of course, in German. Measuring microscopes, collimators, contour projectors, comparators, gage block interferometers, and apparently all such instruments as would be expected in a text of this kind have found their place. One wonders if industry really makes full use of the potentialities of all this equipment. Finally there is a noteworthy section on surface profile determinations, with comparative photographic documentation of results using the profile microscope, the quenched total reflection microscope, and the interference microscope.

The book will serve the student as a reference or even as a text, and it will provide the instrument maker or process engineer with a guide to the solution of many problems in precision measurements.

A. F. TURNER

Bausch & Lomb Optical Company

Trace elements in food. G. W. Monier-Williams. New York: John Wiley, 1949. Pp. viii + 511. $6.00.

The title *Trace elements* has a variety of connotations for different groups. The nutritionist has in mind primarily iron, iodine, copper, manganese, cobalt and zinc. Agriculturists add boron to this group and dentists add fluorine. The toxicologist, while not unmindful of a possible excess of some of the elements named, centers his main interest on the remaining ones. But the health officer and the food chemist must deal with the gamut of elements, since all are encountered in foods, in more or less quantity, sometime or other.

Monier-Williams' *Trace elements in foods* is written primarily from the standpoint of the food chemist. There are 28 chapters, each dealing with a single element except for the last few chapters, which cover several closely related elements. The book is primarily an abstract of the papers to which it refers—about 1,600 in all. In the case of each element half of the discussion deals with the source and amounts in foods, nature or condition of occurrence, function if any, nutritional requirement, availability, assimilability, tolerance, toxicity, retention, excretion etc. The other half of the discussion is devoted to methods of analysis. Its thoroughness in this field should make it a useful book for every food chemist.

The author discusses briefly the philosophy of regulatory measures. He states: "Agreement [between what is clearly toxic and what is undoubtedly harmless] is not likely to be reached without far more complete knowledge of human physiology than we possess at present. Meanwhile, any preference must be on the side of the consumer." But he weakens that statement by another. "It can be urged that where exhaustive animal experiments have shown no sign of injury of any kind, there is no reason to fear any adverse effect on man and no justification for imposing limits and prohibitions which may harass traders and impede progress without conferring any apparent benefit on the consumer." The different reactions of different species and the various susceptibilities of individuals, particularly invalids, within a species justify greater caution than this implies. The "harassing of traders and impeding of progress" have often been overemphasized. One can cite the former wide use of sodium benzoate in ketchup. Now it is outlawed by the federal definition and standard that industry itself largely formulated. Preservatives in milk, a most perishable food, were outlawed when knowledge was very limited as to what could be accomplished by a combination of pasteurization and refrigeration, and facilities for applying them were even more limited. This prohibition was a challenge to the dairy industry. Today the distribution of milk is on a very high level indeed. Abolition of the use of the violently reactive chemicals now being used in the flour and bread industries might be expected to have an equally salutary effect.

At least part of the medical profession was confident that lithium chloride could be used as a seasoning agent to supplant sodium chloride for patients requiring a low sodium intake. Not a single voice was raised against it until a few deaths were reported. Lithium at one time was regarded as an important ingredient of certain so-called health waters. Incidentally, Monier-Williams' discussion of lithium is very brief. The episode mentioned occurred too recently for him to have included it.

Some other omissions are less easily excused. The author states that a tree may be fed manganese through a hole bored in the trunk. He fails to point out the more and more common practice of feeding plants through their leaves. Important commercial applications of the technique are spraying pineapples with iron and citrus trees with manganese, copper, and zinc.

Through an error, the author states that normally 1½ to 1¾ lb of tin is used to coat a base box of steel in making tinplate. In this country 3 percent of hot-dipped plate contains 1½ lb and 97 percent contains only 1.25 lb. The ability of the canning industry thus to spread the limited supply of tin during the war is what made it possible to keep up the supplies of food to both civilians and the military forces.

E. F. KOHMAN

Campbell Soup Company

NEWS and Notes

H. C. Dudley, head of the Biochemistry Division of the Naval Medical Research Institute, Bethesda, Maryland, has been appointed head of the newly organized Allied Medical Sciences Section, Medical Service Corps of the Navy.

U. S. scientists who have been invited by the Paris Centre National de la Recherche Scientifique to attend the colloquium on astronomical constants to be held in Paris, March 27–April 1, 1950, are **G. M. Clemence,** U. S. Navy Observatory, Washington 25, D. C., and **Dirk Brouwer,** of the Yale University Observatory.

William McDowell Hammon, assistant director of the Hooper Foundation, University of California, has been appointed professor and head of the Department of Epidemiology at the Graduate School of Public Health, University of Pittsburgh. In this position Dr. Hammon will also be responsible for the instructional and research interests of the school in the field of microbiology. His appointment is effective February 1, 1950.

William E. Mahin, director of research at Armour Research Foundation of Illinois Institute of Technology, has been appointed a member of the National Research Council for a three-year period ending June 30, 1952. Dr. Mahin will represent the American Society for Metals.

D. A. Fraser, lecturer in botany, University of Alberta, has been appointed forest ecologist, Forest Insect Laboratory, Dominion Department of Agriculture, Sault Ste. Marie, Ontario.

Eric Ogden, formerly of the University of Texas, Medical Branch, Galveston, has been appointed professor and chairman of the Department of Physiology at the College of Medicine, Ohio State University.

The Atomic Energy Commission has appointed two new branch chiefs to its Washington headquarters staff. They are **Walter D. Claus,** former head of the Physical-Chemical Division of the Pabst Research Laboratories, Milwaukee, as chief of the Biophysics Branch, Division of Biology and Medicine, and **Joseph B. Platt,** former associate professor of physics, University of Rochester, as chief of the Physics Branch, Division of Research. Dr. Claus replaces **Lauriston S. Taylor,** who has been on loan from the National Bureau of Standards. Dr. Taylor will return to the position of chief of the X ray Section and will act as consultant to the AEC on radiation matters.

Hsien Wu, visiting scholar, College of Physicians and Surgeons, Columbia University, has accepted a position as visiting professor of biochemistry at the Medical College of Alabama, Birmingham. Dr. Wu was professor of biochemistry at Peiping Medical College from 1928 to 1941, and, in 1944, director of the Nutrition Institute, Ministry of Health, China.

Paul E. Clark, physical chemist and former head of the Department of Chemistry at Washington and Jefferson College, Washington, Pennsylvania, has accepted a position as technical reports writer at the Applied Physics Laboratory of Johns Hopkins University, Silver Spring, Maryland.

Visitors to U. S.

Recent visitors at the Plant Industry Station at Beltsville, Maryland were **Sir William G. Ogg,** director of the Rothamsted Experimental Station in England, and **C. H. Edelman,** director of the Soil Survey in Holland and president of the International Congress of Soil Science.

Recent visitors at the Department of Agriculture were **Gregorio Rosenberg M.,** head of horticultural research, Ministry of Agriculture, Santiago, Chile; **René L. Ambroise,** chief of the Soil Conservation Service, Haitian Department of Agriculture; and **Julio Peña,** professor of chemistry, Central University of Quito, Ecuador.

Visitors at the National Bureau of Standards September 19–30 included: **J. F. Allen,** professor of physics, St. Andrew's College, Scotland; **K. R. Atkins,** physicist, Cambridge University, England; **Axel Bernstein,** metallurgist, the Sandvik Steel Works, Sandviken, Sweden; **A. Fogg,** director, Motor Industry Research Association, Brentford, England; **W. D. Forrester,** field engineer, Canadian Geodetic Survey, Ottawa; **Felix A. Galavis S.,** chief of the Geological Laboratory, Ministeriode Fomento, Caracas, Venezuela; **Sir Charles Goodeve,** director, British Iron and Steel Research Society, London; **A. Goodewaagon,** chemical engineer, Donda, Netherlands; **H. O. Hartley,** lecturer in statistics, University of London, London; **Francis M. Henderson,** senior design engineer, Dominion Physical Laboratory, Department of Scientific and Industrial Research, Wellington, New Zealand; **P. Lainé,** physicist at the Bellevue Laboratory, France; **J. M. Los,** physicist, National Research Council of Canada; **M. Meissner,** professor of physics, Technical Institute, Munich; **F. E. Simon, K. Mendelssohn,** and **A. H. Cook,** professors of physics at the University of Oxford, England; **D. S. Montgomery,** Canadian Bureau of Mines, Ottawa, Canada; **J. Singer,** director, Central Organization for Applied Scientific Research for the Netherlands, the Hague; **Hilding Slatis,** professor, Nobel Institute for Physics, Stockholm; **R. A. Smith,** physicist with the British Ministry of Supply, London; **Serge Staub,** sugar technologist, Department of Agriculture, Great Britain, Reduit, Mauritus Island; and **F. W. Wood,** in charge of Watheroo Ionospheric Observatory, Department of Mineral Resources, Melbourne, Australia.

Ryokichi Sagane, professor of physics at Tokyo Imperial University, will spend six months as visiting professor at the Institute for Atomic Research, Iowa State College, beginning January 1. Dr. Sagane will deliver a series of lectures and confer with staff members associated with the synchrotron.

Grants and Awards

The Federal Security Agency has announced the distribution of $3,250,000 among nine teaching institutions to assist in construction of cancer research laboratories. Recipients are: *University of Minnesota,* $200,000 for two floors of clinical research at the Mayo Memorial Medical Center; *University of Chicago,* $240,000 to aid construction of the seven-story Goldblatt Memorial Hospital for Cancer Research; *New England Deaconess Hospital,* Boston, $85,000 for two floors adjoining the New England Deaconess Cancer Institute; *University of Kansas,* $200,000 for one wing of a two-story building for laboratory and clinical research at the University Medical Center; *Johns Hopkins University,* Baltimore, $750,000 to aid construction of cancer research facilities; *St. Louis University,* $625,000 for a new clinical research building at the University Medical School; *University of California,* Los Angeles, $700,000 for a wing of the medical school; *University of Pennsylvania,* $200,000 for a one-half-floor laboratory; and *Memorial Hospital for Cancer and Allied Diseases,* New York, $250,000, for an additional floor for an experimental surgical laboratory.

The John Fritz medal for 1949, for "scientific or industrial achievement," has been presented by the Engineering Societies to Walter Hull Aldridge, president of the Texas Gulf Sulphur Company. Mr. Aldridge was cited for his contribution to the mineral production of the U. S. and Canada. The societies have also announced that the 1950 **Daniel Guggenheim Medal** for achievement in aeronautics will be given to Edward P. Warner, president of the Interim Council of Provisional International Civil Aviation Organization.

Carnegie Institute of Technology has awarded $1,000 graduate fellowships in engineering to René Saul M., Mexican electrical engineer formerly associated with RCA Victor Mexicana, and Edilberto Vega P., Peruvian civil engineer who has worked with the Department of Public Works and the Division of Sanitary Projects in Lima. The fellowships are granted annually to Latin Americans in the interest of intercontinental unity.

The National Institutes of Health have awarded to **John C. Krantz, Jr.,** professor of pharmacology, School of Medicine, University of Maryland, a grant of $6,500 for study of the mechanism of the action of drugs on the cardiovascular system.

Grants totaling $8,614,737, to be administered by the **National Heart Institute of the Public Health Service,** have been awarded 85 medical schools and research institutions in 34 states and the District of Columbia. The funds will be used for heart research, expanded programs of heart teaching in medical schools, and for building additional heart research laboratories throughout the country. The grants are in addition to those awarded in July (amounting to $1,200,000 for continuing research projects already under way) and provide a total of nearly ten million dollars in federal funds appropriated during the fiscal year ending June 30, 1950 to combat heart disease. The categories of the grants are: $2,053,310 for 189 research investigations in 66 nonfederal institutions in 28 states and the District of Columbia; $671,032 for improving and expanding cardiovascular teaching in 46 medical schools in 28 states and the District; and $5,890,395 for providing research laboratory facilities for study of heart diseases in 22 nonfederal institutions.

The Atomic Energy Commission Division of Biology and Medicine has approved 18 research proposals in biology and medicine during the past three months. The institutions and their research projects are: Massachusetts General Hospital—*William M. Sweet* and *Bertram Selverstone,* for the use of phosphorus-32 in the precise localization of brain tumors; University of Oregon Medical School—*Edward E. West,* for a study of labeled acetic acid and ethanol in relation to fat metabolism; University of Tennessee—*E. F. Williams,* for research in pathology, physiology, and chemistry; Presbyterian Hospital of the City of Chicago—*E. Gordon Gould,* for study of the mechanism of CO_2 fixation; Peter Bent Brigham Hospital—*Francis D. Moore,* for study of intracellular changes in trauma depletion and repair, and biochemical studies in the human being with the aid of isotopes; University of Denver—*Frank M. D'Amour,* for study of the physiologic and pathologic effects of radioactive cobalt; Harvard University—*Thomas H. Ham* and *William B. Castle,* for study of the destruction of red blood cells; Harvard University—*S. P. Hicks,* for study of the effects of radiation upon the development of rat embryos; Syracuse University—*E. L. Losner,* for study of the defenses against hemorrhages; Washington University, St. Louis—*Frank Dixon,* for investigation of the effects of agents used in the treatment of cancer, and study of x rays and nitrogen mustards on the immunologic response of experimental animals; University of Illinois—*A. C. Ivy,* for irradiation of gastric mucosa by intragastric instillation of radioactive isotopes; Iowa State College—*S. Aranoff,* for study of the metabolism and physiology of roots, and *R. E. Sealock,* for study of combined biochemical and physiological actions of throsine and vitamin B_{12}; Agricultural and Mechanical College of Texas—*Raymond Reiser* and *Kenneth Kuiken,* for study of the metabolism of glycerines; University of Pennsylvania—*D. Wright Wilson,* for study of the synthesis of isotopic carbon compounds used in biochemistry; University of Chicago—*E. M. K. Geiling,* for the study of biosynthesis of radioactive drug compounds; University of Wisconsin Experiment Station—*B. W. Burris* and *P. W. Wilson,* for studies of biological nitrogen fixation with isotopic tracers, and study of the metabolism of organic acids in higher plants and microorganisms; University of Washington—*F. W. Church* and *Raymond Allen,* for meteorological studies; *Robert G. Fleagle,* for meteorological studies.

Negotiations leading to the award of contracts covering the newly approved research projects are now under way and contracts will be awarded by the AEC operations office nearest the institution conducting the research.

The award of contracts to the institutions involved will bring to a total of 150 the number of AEC-supported research projects being carried on in medicine, biology, cancer studies, and biophysics at universities, hospitals, and research centers. Approximately five million dollars has been allocated by the AEC for support of such research in nongovernment agencies during the fiscal year 1950.

Meetings and Elections

A series of 12 weekly lectures on the **Psychology of Emotional Growth** began on October 11 at Cooper Union in New York City. The series is open to the public without charge or seat reservations.

The National Academy of Sciences will hold its autumn meeting at the University of Rochester, New York, October 24–26. Abstracts of papers presented will be published in the October 28 issue of *Science*.

The Engineers' Council for Professional Development will hold its 17th annual meeting at the Edgewater Beach Hotel in Chicago October 28–29. Programs may be obtained in advance of the meeting by writing to George G. Lamb, Technological Institute, Northwestern University, Evanston, Illinois.

The 450th meeting of the **American Mathematical Society** will be held at Columbia University on October 29. R. H. Fox, of Princeton University, will deliver an address on covering spaces.

The Fourth Annual Congress on Horticulture will be held October 30–November 1, at the Essex House, New York City. The congress will include a symposium and round table on color, preliminary to the publication of a 2,000-color standard chart by the Commission on Testing and Reporting of the American Horticultural Council. Further details may be obtained from R. Milton Carleton, 601 West Jackson Boulevard, Chicago 6.

The Gulf and Caribbean Fisheries Institute will hold its second annual meeting November 15–18, at the Robert Richter Hotel, Miami Beach, Florida. Papers will be presented by delegates from Cuba, Martinique, and other Caribbean countries, as well as from the southeastern states of the U. S.

ACS at Atlantic City. One thousand sixty-five papers—by far the largest number in the history of the American Chemical Society—were presented at the society's 116th national meeting, held in Atlantic City, New Jersey, September 18–23, with 8,232 chemists and chemical engineers participating. Nineteen professional divisions of the society held 151 technical sessions, at which advances in virtually every chemical field from agriculture and biology to petroleum and rubber were reported.

An optimistic keynote was provided by Arthur B. Lamb, of Harvard University, retiring editor of the *Journal of the American Chemical Society*, who received the Priestley Medal at a general assembly in the Atlantic City Convention Hall. Science, whose revolutionary progress has plunged man into the maelstrom of social upheaval, will lead him safely through into a better world than he has ever known, Professor Lamb declared. Despite the grave problems now confronting civilization, there is no need to be "unduly depressed," he said, because "fundamentally, and for the long pull, mankind's prospects have never been brighter."

An appeal to private industry to insure its own continuing progress and the future welfare of the nation by creating a $75,000,000-a-year foundation for the support of basic research was made by the society's president, Linus Pauling, of the California Institute of Technology. Such a foundation would not eliminate the need of federal aid for research, but it would avert the menace of bureaucratic domination of scientific study and thus help preserve the American system of free private enterprise, Professor Pauling said.

The names of seven 1950 award recipients were announced by Dr. Pauling. They are:

Garvan Medal—Pauline Beery Mack, director, Ellen H. Richards Institute of Research in Textiles and Nutrition, Pennsylvania State College; *American Chemical Society Award in Pure Chemistry* (financed by Alpha Chi Sigma)—Verner Schomaker, California Institute of Technology; *Precision Scientific Company Award in Petroleum Chemistry*—Kenneth S. Pitzer, (University of California), director of research, Atomic Energy Commission; *Eli Lilly and Company Award in Biological Chemistry*—William Shive, University of Texas; *Fritzsche Award in Essential Oils*—A. J. Haagen-Smit, California Institute of Technology; *Fisher Award in Analytical Chemistry*—Isaac M. Kolthoff, University of Minnesota; *Paul-Lewis Laboratories Award in Enzyme Chemistry*—Britton Chance, director, Johnson Foundation, University of Pennsylvania. The awards will be presented at the society's spring meeting, which will be divided into three sessions at Houston, Philadelphia, and Detroit.

First announcement in the U. S. of the decisions of the International Union of Chemistry on the names of plutonium and 13 other elements was made at the ACS meeting. Alexander Silverman, University of Pittsburgh, American representative on the union's Commission on Inorganic Nomenclature, who had just returned from the union's 15th conference in Amsterdam, reported that these names had been accepted for the eight new elements discovered during World War II: technetium (43), promethium (61), astatine (85), francium (87), neptunium (93), plutonium (94), americium (95), and curium (96). He also listed the following rulings on names of older elements: wolfram instead of tungsten for number 74; niobium instead of columbium for 41, beryllium rather than glucinium for 4, hafnium for 72, lutetium rather than lutecium for 71, and protactininum rather than protoactinium for 91.

Widespread interest was aroused by a symposium on "Security Clearance and the Scientist," sponsored by the society's Industrial and Engineering Division, at which Colonel E. M. Tally, Jr., chief of the Munitions Board's Office of Manpower, announced that the Department of Defense is establishing a central security file to make the entire clearance system simpler and to eliminate much of the duplication existing under separate Army, Navy, and Air Force procedures.

Discovery of a simple, low-cost method for the mass-scale production of essential amino acids for safe intravenous feeding was reported by Jesse P. Greenstein, of the National Cancer Institute.

Recent findings in the biochemical study of diabetes, achievements in the flameproofing of textiles, the varied industrial uses forecast for titanium, and developments in the fields of paints, plastics, rubber, and insecticides were among the other subjects discussed at the meeting.

WALTER J. MURPHY

The Mt. Desert Island Biological Laboratory is planning to issue early in 1950 a *Bulletin Number* covering the years 1941–49, and a list of papers resulting from work at the laboratory from 1929 through 1949. All contributors are asked to submit titles of published papers or a sentence description of unpublished work by *December 1* to J. Wendell Burger, Director, Trinity College, Hartford 6, Connecticut.

The Philadelphia Section of the American Chemical Society will sponsor again this fall special noncredit evening courses in physiology for chemists and recent developments in colloid chemistry. The lectures will be held at the Philadelphia College of Pharmacy and Science, 43rd and Kingsessing Avenue, Philadelphia. Attendance is not limited to members of the American Chemical Society. Further information may be obtained from E. J. Rosenbaum, Sun Oil Company, Norwood, Pennsylvania, chairman of the Philadelphia Section's Chemical Education Committee.

The New York Academy of Medicine has donated 12,000 volumes to the Southwestern Medical College in Dallas, Texas. These volumes are part of a gift to the academy of 20,000 volumes from the New York Public Library, representing its original collection of medical books accumulated during the 19th century. The academy is adding the remaining 8,000, including valuable foreign medical publications and issues of unusual journals, to the 260,000 volumes of its present library.

The National Bureau of Standards has just published its annual report summarizing investigations in the physical sciences carried on at the bureau during 1948. Activities were conducted by 14 divisions, concerned with electronics, applied mathematics, atomic and molecular physics, radio propagation, electricity and optics, metrology, heat and power, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, and commodity standards. Of the projects carried out by approximately 100 sections within these divisions, those of greatest general interest and widest application have been selected for description. The 272-page illustrated booklet is available from the U. S. Government Printing Office, Washington 25, D. C.

The New York Academy of Sciences, now located at Central Park West and 79th Street, New York City, will occupy new headquarters at 2 East 63rd Street after January 1. The new residence is the million-dollar gift of Norman B. Woolworth. The academy is conducting a campaign for one million dollars, half to be used for alteration, equipment, and maintenance of its new home and half to be set aside for an extension of activities.

Recently Received—

Medical Mission to Greece and Italy, April 15–June 7, 1948. Abridged report. Unitarian Service Committee, Inc., 9 Park Street, Boston 8.

Sixth Report of the Biological Bureau, Quebec, 1948. Game and Fisheries Department, Quebec, Canada.

The Navajo Meteorite. Sharat Kumar Roy and Robert Kriss Wyant. Geological Series of Field Museum of Natural History, Chicago. Vol. VII, No. 8. 30¢.

List of Publications, Department of Terrestrial Magnetism, 1948. Carnegie Institution of Washington, Washington 15, D. C.

Handbook on Florida Termites. E. Morton Miller. Technical Series, University of Miami Press, Coral Gables, Florida.

Proceedings of the First Annual Northern California Research Conference, January, 1949. Stanford Research Institute, Stanford, California. $2.00.

Un diagramme nouveau a quatre coordonnees. P. Lenk-Chevitch. Extract from technical bulletin of l'Union des Ingenieurs sortis des Ecoles Speciales de l'Universite de Louvain, Brussels.

Isotopes, Catalogue and Price List No. 3, July 1949. Isotopes Division, U. S. Atomic Energy Commission, Oak Ridge, Tennessee.

Ecological Crop Geography of Germany and Its Agro-Climatic Analogues in North America. M. Y. Nuttonson. International Agro-Climatological Series, Study No. 8, 1949. On request from American Institute of Crop Ecology, P.O. Box 1022, Washington, D. C.

A Collection of Fishes from Talara, Peru. Samuel F. Hildebrand and Otis Barton. Miscellaneous Collections, Vol. III, No. 10, Publ. 3986, Smithsonian Institution, Washington, D. C.

Make Plans for—

Pacific Chemical Exposition and **Pacific Industrial Conferences,** sponsored by the American Chemical Society, November 1–5, Civic Auditorium, San Francisco.

Special Libraries Association, council meeting, November 3–5, Hotel Statler, New York City.

American Association of Blood Banks, November 3–5, Seattle, Washington.

Society of Rheology, 20th annual meeting, November 4–5, Hotel New Yorker, New York City.

American Society for the Study of Arteriosclerosis, November 5–7, Hotel Knickerbocker, Chicago.

American Society of Tropical Medicine, meeting conjointly with the **National Malaria Society** and **American Academy of Tropical Medicine,** November 6–9, Memphis, Tennessee.

Attacks on Muscle

A. Szent-Györgyi[1]

Marine Biological Laboratory, Woods Hole, Massachusetts; and
Laboratory of Physical Biology, National Institutes of Health,
Bethesda, Maryland

UP TO THE PRESENT CENTURY muscle was the favorite object of physiological research. An enormous amount of work carried on by classical methods was repeated later with perfected physical methods. The results of such refinements failed to leave in their wake a deeper understanding than had been obtained before. The reason lies in the wholistic nature of approach. To the physiologist muscle and a muscle twitch are units which cannot be disintegrated.

Attempts to understand muscle by breaking it down to its molecular components date back to the sixties, when W. Kühne (*7*) prepared from muscle a globulin-like protein, myosin, supposedly derived from contractile fibril. Leading contemporaries, Danilevski, (*2*) Halliburton (*5*), and v. Fürth (*11*), corroborated and extended the observation. In the thirties of our century the study of myosin was again taken up by more modern methods (*12*).

Though interesting and specific relations of myosin and ATP were discovered (*4*), the mechanism of contraction and the role of myosin remained obscure.

A third line of attack was taken up in the author's laboratory ten years ago at Szeged and later at Budapest, Hungary. This line was based on the belief that such a complex mechanism as the contracting muscle fibril can be understood neither by keeping it as a whole nor by decomposing it to molecules. It was believed that an understanding could be achieved by breaking the system down gradually, dismantling it step by step, always trying to put together again what we have taken to pieces. It was further believed that no single method of investigation could give the desired information. All methods available had to be employed in one single coordinated effort.

Two years ago the author started organizing such an attempt in this country. Part of this research group is working at the National Institutes of Health at Bethesda, Maryland, and part at the laboratory of the Institute of Muscle Research at the Marine Biological Laboratory in Woods Hole, Massachusetts. In the middle of August the two groups convened at Woods Hole to discuss their problems and methods, the meeting being attended by a few guests interested in muscle. Out of these discussions a new conception of muscular contraction seems to have emerged.

The contractile structure is built of a protein complex, "actomyosin," discovered at Szeged. The "myosin" partner of this complex is in many ways different from earlier myosin and was crystallized by the author. Actin was isolated by F. B. Straub (*12*). In itself, neither actin nor myosin *shows any sign of contractility, nor does actomyosin* in itself. What makes it work is the master substance of muscle, ATP.

Adenosine triphosphate is a water-soluble nucleotide consisting of small molecules. Its existence was only gradually recognized. Embden (*3*) described adenosine phosphate and Meyerhof and Lohmann (*8, 9*) showed that in muscle adenosine was linked not to one but to three phosphate groups; hence the name ATP, abbreviation for adenosine triphosphate. This ATP contains, in the links holding its phosphate groups together, 11,000 cals of free energy which, according to our present knowledge, is the sole immediate source of the energy of muscular contraction. *But ATP is not merely a store of energy.* It dominates the whole physical state of muscle. Without it muscle is not only inactive but is also stiff and inelastic. Muscle in *rigor mortis* is actually muscle with no ATP.

Myosin, if not linked to actin, has one striking property, its great affinity to ions. It binds ions very strongly so that its physical state, charge, and solubility depend on the quality and quantity of ions present. Though it is a hydrophylous colloid, myosin is discharged and quantitatively precipitated by 0.025 M KCl or NaCl. It has an especially great affinity to Mg, which is always present in muscle in high concentration. Myosin, by binding Mg and K, develops a high affinity to ATP, with which it links up to a fairly stable complex, "myosin-ATP."

Actin, too, has its striking peculiarities. The most surprising one is that it can exist in two forms, in the form of globules and in the form of long threads.

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[1] Public Health Service Special Fellow of the National Institutes of Health.

If extracted by Straub's method, it is in the globular form (G-actin) consisting of small, round molecules of mol. wt 70,000 g. If a small quantity of salt, KCl or NaCl, is added in the presence of traces of Mg, the globules unite to long threads, studied first under the electron microscope by Jakus and Hall (*6*). These relatively thick threads give no information about their finer structure, or the mechanism of the building of threads out of globules. If, however, thread formation is induced under special conditions, as it was by G. Rozsa, the author, and R. W. G. Wyckoff (*10*) at the National Institutes of Health, actin forms very thin molecular threads. If these threads come to lie side by side they develop a cross striation. The distances of this striation can be exactly measured, allowing us to draw some conclusions as to what has happened. What we find is that the small actin globules of mol. wt 70,000 g have united to form bigger units, about twenty of them now forming one particle of mol. wt about 1,500,000 g. These units are slightly elongated, 100 A wide and 300 A long; they associate end-to-end to form long fibers. If several fibers come to lie close to one another the particles of the neighboring threads associate also with their broad side.

Myosin consists of very thin and long molecules. If these are added to fibrous actin the two colloids unite to form a complex. The slender, long myosin filaments attach themselves to the actin filament lengthwise. The reactions of this complex are rather sluggish. If ATP is added it links up with the myosin to form an actomyosin-ATP complex which has the most amazing reactivity. The reactions depend now on the salt concentration. At a high salt concentration the complex dissociates into its components, actin and myosin-ATP. By changing the salt concentration by no more than 0.01 M we can make actin and myosin-ATP unite or dissociate at will. The ionic concentrations of intact muscle are such that the system is balanced on a razor edge and the two proteins just do not unite. The shift in ionic concentration, necessary for their union, is brought about by the wave of excitation and the concomitant electric current.

In the absence of ATP the actomyosin filaments are stable in their straight, stretched condition. Actomyosin-ATP is unstable in this condition. When actin and myosin-ATP unite they lose their charge and therewith they dehydrate and tend to shrink and fold up, going over into a shorter, more stable, and energy-poorer state.

If we do not allow the system to shorten by holding its ends fixed, tension will be developed. Using thermodynamic language we could also say that, by uniting, the two proteins acquire a thermodynamic potential which is dissipated in shortening. Using the language of colloidal chemistry we can also say that contraction is a mutual precipitation of two proteins, or a precipitation of a protein complex by ions, since ions are also involved.

The reaction in which the potential is developed is thermodynamically reversible; it is thus an equilibrium reaction. From the temperature dependence of its constant, free energy changes can be calculated which are in agreement with experiments measuring the work actually done. In these reactions the actin, together with the corresponding quantity of myosin, forms independent units, which react in an all-or-none fashion, that is, either react completely or not at all. Muscular activity is the sum of the independent function of these little units, the size and energy changes of which can be calculated with fair accuracy.

While contraction seems to be clearing up, we still know very little about relaxation and energy coupling. We do not know how the muscle goes back to its resting state and at which point of the cycle the ATP is split and how its energy is utilized by the protein. A recent discovery of F. B. Straub, corroborated and extended by W. Bowen and K. Laki (*1*), together with the author's earlier observations, offers the possibility of a tentative explanation. Straub found that ATP is involved in the polymerization of actin. The author observed that fibrous actin is broken up into globules during contraction of actomyosin, that actin in its globular form dissociates from myosin-ATP much more readily than fibrous actin, and that myosin greatly catalyzes the rearrangement of actin globules to fibers. Hitching all this together the following picture can be made: ATP is instrumental in holding the actin-globules together in fibers. This ATP is split in contraction by the myosin (which is known to have ATP-ase activity). The actin fiber thus falls into globules which dissociate from the the myosin-ATP. The actin globules unite spontaneously to fibers again while myosin-ATP molecules hydrate and stretch out, since myosin-ATP, if not attached to actin, hydrates spontaneously at the ionic concentration of muscle.

In this picture the difficult problem of energy coupling ("energetization") drops out altogether. If the actomyosin-ATP system contracts and performs, say, *X* calories' worth of work, we cannot expect to be able to dissociate it without using up *X* calories' worth of energy in bringing about this dissociation. (If the system dissociates it can go back spontaneously into the relaxed resting state and if we could make it dissociate without using up energy then we would have a net profit of X calories, that is, we would have a *perpetuum mobile.*) There being no *perpetuum mobile* possible, we can state that if the muscle has done X calories of external work in contraction we need at least X calories' worth of energy to make it dissociate and relax. Since the splitting of the phosphate link of the ATP molecules holding the actin globules together entails dissociation and relaxation, we need energy to bring about its splitting. The problem is solved by nature—by enclosing into the phosphate bond the energy necessary for its later splitting. In this way the link can be split at the right moment in contraction without external help, the energy needed for this splitting having been enclosed in the phosphate bond at its formation. The final source of this energy of the "high energy phosphate bond," which has to pay for all the energy expenditure of contraction, is our food, its oxidation and fermentation.

The reader will have noticed that in developing this concept of contraction the most varied methods were used. A deeper understanding of muscular activity can be arrived at only by coordinated attack on all available lines, be they histology, electron microscopy, preparative chemistry, enzymology, colloidal chemistry, physiology, or even quantum mechanics. The meeting held at Woods Hole represents such an attack.

A deeper understanding of muscle is urgently needed for two reasons. Cardiovascular diseases, which take such a horrid toll, are mostly diseases of muscle, be it the heart muscle itself or muscle cells of the artery wall. It should not be forgotten that the immediate cause of most human death is failure of muscle, and its dysfunctioning causes a great deal of suffering. No rational therapy or prevention can be hoped for without deeper understanding of muscle. Also, we can replace missing, or worn out, parts of a mechanism only if we know about them, and so the analysis of muscle may bring to light substances of therapeutic value. The author has worked out methods for the large scale preparation of ATP making this master substance of the muscle available for medical use, and suggested its clinical trial in all conditions in which dysfunctioning of muscle is involved. Most encouraging results have been reported in various lines.

The fact that ATP is involved in the construction of the bigger functional units of actin indicates that this substance is, so to speak, a mortar of the living edifice. Thus it is imperative to try its clinical application also in degenerative diseases, like arthritis, where the basic biomolecular architecture seems to be impaired.

Relieving human suffering on a big scale may be very gratifying, but all the same, the mainspring of basic research is curiosity, the thirst for new truth and knowledge. Success in therapy is but a natural consequence of such deeper knowledge. Muscle, as a material, holds out the highest promise for those who want to understand the basic principles of life and its architecture.

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The Cortical Correlate of Pattern Vision[1]

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BOTH PHYSIOLOGISTS AND PSYCHOLOGISTS are convinced that psychological facts are directly related to certain brain processes, which determine the various characteristics of these facts. Such processes are called the cortical correlates of the phenomena in question. No actual demonstration of cortical correlates has so far been possible, and their nature has remained a matter of speculation. In the case of vision, it is true, operations of the cortex are not entirely unknown. When the organism is in a relaxed condition, the visual area of the brain, but not this area alone, exhibits the alpha rhythm, an electric oscillation of about 10 cycles per second. Since this rhythm is most pronounced when the eyes are closed, and is disturbed by visual facts, nobody regards it as the correlate of these facts as such. A few electric waves are also observed when the visual cortex is thrown into action by stimulation of the eyes; and some waves may again occur when stimulation is discontinued. But such on- and off-effects cannot be related to vision in general, because they accompany only its beginning and its end.

Many believe that cortical function is essentially of the same type as peripheral function; in other words, that nerve impulses which arrive in the cortex merely give rise to further impulses which travel in cortical fibers. This thesis meets with a serious difficulty: large masses of cortical cells tend to operate as though each were taking account of what the others are doing. Thus, Gerard (*2*) suggested that, quite apart from impulses which are transmitted in fibers, brain action may involve fields which spread through the tissue as a continuum. Later he and Libet showed that parts of the brain remain functionally interrelated even when all connecting fibers have been severed, or when their synapses are blocked by drug action (*3, 4, 8*). In the meantime, psychological evidence had led to the assumption that, when the level of activity in adjacent parts of the visual cortex differs, a direct current flows around the contour at which they are in contact (*5, 6*). An investigation of so-called figural after-effects in vision strongly supported this assumption (*7*). Just like Gerard's fields, the currents in question were supposed to spread through the brain as a volume conductor. This is not a bold assumption. The short-lived current of a nerve impulse flows through the surrounding medium no less than through the active stretch of the fiber, although in general discussions about the operations of the nervous system the fact is sometimes ignored. Again, since the alpha rhythm of human subjects is commonly registered when the electrodes are attached to the surface of the head, this activity of brain cells must also have fields which spread in the tissue as a continuum. Electric displacements which readily penetrate skull and scalp are not, of course, restricted to special conductors in the brain.

In the theory of visual perception, we cannot be satisfied with the general hypothesis that, when a subject sees objects or patterns, corresponding parts of his visual cortex are pervaded by direct currents. If it is assumed that such currents determine certain characteristics of the visual field, it will be necessary to show more specifically how these characteristics can be derived from the behavior of the cortical flow. But this is by no means an easy task. We therefore decided to postpone further theorizing until we had better evidence to support the main hypothesis, and tried to find such evidence in direct physiological tests.

Although later it will be necessary to take records from the brains of animals whose skulls have been opened, recording from the intact heads of human subjects appeared to us more convenient in a first exploration. This procedure had to give results if the size of the postulated potentials could be assumed to be comparable to the amplitude of the alpha rhythm. As our main instrument, we used the breaker type d-c amplifier constructed by the General Motors Company (*10*); the amplified current was registered with a photoelectric recorder of the General Electric Company. The subject was seated in a shielding cage. We used electrodes of the silver-silver chloride type. Usually, one electrode was placed slightly above the occipital protuberance, where the foveal region of the visual cortex is located, and the second electrode was attached to the vertex. Under these conditions, the vertex electrode was connected with the grounded parts of the amplifier and the shielding cage. Steady potentials appearing in the absence of visual stimulation were eliminated by a balancing circuit.

All currents which spread in the nervous system tend to reduce their own intensity by immediate polar-

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[1] Work done under grants from the American Philosophical Society, the Viking Fund, and Swarthmore College.

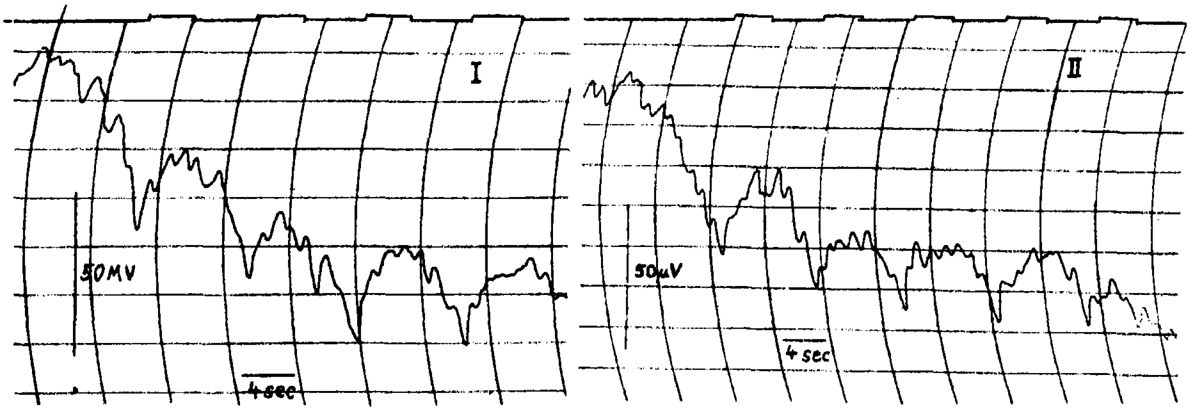

FIG. 1. Record I, subject S, four responses to four exposures of a bright moving object. Record II, subject S, five responses to five exposures of a moving object.

ization of the tissue.[1] We tried to minimize this difficulty by showing the subject bright objects that were slowly moving rather than stationary. Actually, it is more difficult, although not impossible, to obtain responses also in the latter situation. The objects did not move with a very high speed; we have sometimes used velocities of only 3° of visual angle per second. The records we will show here were taken with retinal speeds that varied from about 6° to 12°. It has been reported that moderately bright objects give better on-effects than very intense objects. It is our experience that objects which do not differ too strongly from their background are most likely to give good results. The reason is probably that the advantage which arises from working with a moving object is lost if the object, or rather its current, is strong enough to polarize parts of the visual area before the stimulus actually reaches these parts. We have used moving strips of white or gray cardboard, seen against a dark background in a fairly well illuminated room, as well as moving bars of light projected on a screen under conditions of lower general illumination. Of the records to be shown in this report, only the first, the second, and the fifth have been taken in the latter situation. The objects always had a vertical orientation, and moved in the horizontal direction.

When studying the on-effects of the rabbit's visual cortex, Bishop once remarked that "the variety in the records taken under as nearly constant conditions as we are able to maintain would be discouraging in experiments on any other structure than the cerebral cortex . . ." (*1*). This statement also applies to our records, which often show irregularities of unknown origin. But we should have to regard these records with suspicion if there were no such irregularities. Even in a very calm subject, processes are bound to occur which are not related, or related only indirectly, to the fact that an object moves in his visual field. We have taken records from 13 subjects altogether. All have given responses, although results have been more satisfactory with some than with others. The curves we will now discuss show responses of four different individuals.

When Record I (Fig. 1) was taken, the object moved four times in succession across a screen, in the middle of which a faint fixation mark was given. Both electrodes were placed in the median plane of the head, one in the region of the visual cortex, the other near the vertex. In examining this record, one has to keep in mind that it is written on very slowly moving paper (cf. the length of 4 sec given below the record). It will be seen that there are four responses corresponding to the four marks on top, which indicate the time and the length of the exposures. The responses are maximal in the middle of the exposures, i.e., when the object passes the fixation mark and, in the visual cortex, the place of the occipital electrode. The total length of the four exposures with the intervals between them is about half a minute. During this period the base line has drifted considerably. It is nevertheless obvious that all responses are deflections downward. With the connections of our arrangement, this means that, when the object moves across the fovea, the surface of the cortex under the occipital electrode is positive in relation to the vertex. The size of the responses amounts to slightly more than 25 μv. The small waves which the curves exhibit represent the subject's very slow and steady pulse. It appears in almost all his records, but is disturbing only with some positions of the electrodes.

Record II is a repetition of the same experiment, with the same subject, but with five successive exposures. Although in this case the base line has begun to drift before the exposures, the five responses are

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[1] To be exact, not only is the tissue polarized; its polarisability also grows.

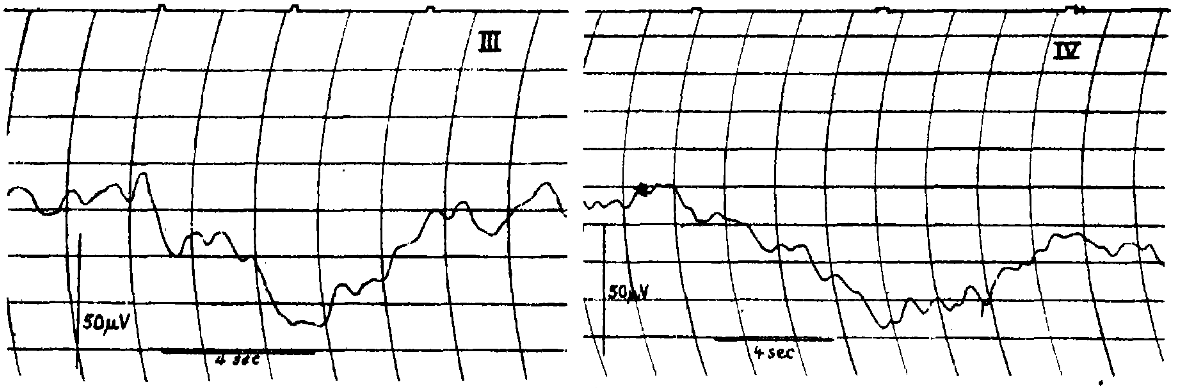

FIG. 2. Record III, subject M, one response to a longer exposure. Record IV, subject M, response to one exposure (12 sec).

again clearly discernible. They have the same polarity as those of Record I, and also almost the same size.

In Records I and II, responses give the impression of being short waves, merely because the records are written on very slowly moving paper and because the extension of the movement is restricted. Records III and IV (Fig. 2), taken from another subject, but with the same position of the electrodes, show reactions to single exposures of objects when the extension of the movement approximates 100° of visual angle, and when the paper of the recorder moves three times as fast as in Records I and II. In both records, there is an almost immediate response when the object begins its movement far in the periphery of the field (cf. the first mark on top). The deflection, which is again positive, grows as the object approaches the fixation mark; it becomes maximal near or at this point (second mark on top), and it gradually decreases as the object moves toward the end of its course (third mark). In Record IV, which is taken with a more slowly moving object, the total time of the exposure amounts to 12 sec. During this period, a current of constant polarity flows from the head into the amplifier. Its greatest intensity corresponds to about 40 μv. The fact that the deflection begins when the object moves at a distance of almost 50° from the fovea deserves particular attention. If such responses actually issue from the visual cortex, parts of this area seem to be interrelated by currents across very considerable distances.

Record V (Fig. 3), taken from a third subject, differs from Records I–IV mainly by the fact that the slowly responding galvanometer (of the recorder) used in the preceding experiments is now replaced by a much faster instrument. The response time of this instrument is .04 sec. As a result, Record V is covered with comparatively rapid oscillations, which the slower instrument could not register. The major positive deflection, which reaches its maximum (about 50 μv) at the fixation mark, is nevertheless perfectly obvious. In the present case, the response is restricted to the middle of the exposure (about 30° of visual angle). This happens occasionally, even if, with the same subjects, other responses extend from the beginning to the end of a wide exposure field. The variation may be related to differences in the attitude of the subjects who, while they fixate, may either concentrate on the fixation mark or follow the object with their attention.

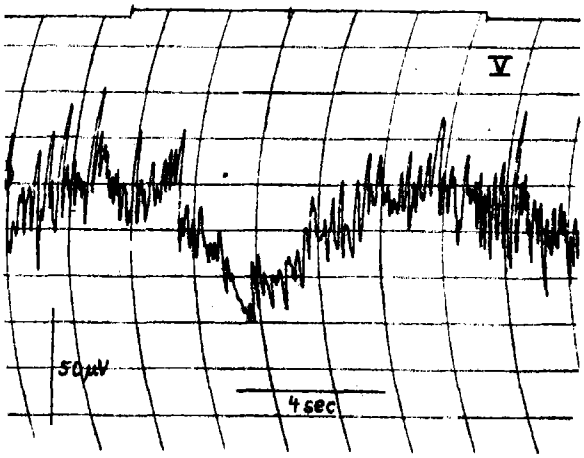

Fig. 3. Record V, subject R, response to one exposure, with alpha waves.

When counting the faster oscillations in the periods before or after the exposure, one finds that their frequency is almost 10 cycles, the average frequency of alpha. In our experiments, this rhythm is never really suppressed when the visual environment remains more or less constant for some time. But changes, such as the movements of our experimental objects, tend to disturb the rhythm, at least for a while. Thus, in this record, the frequency, the amplitude, and the regularity of the oscillations appear to be affected during the exposure, particularly during its central part.

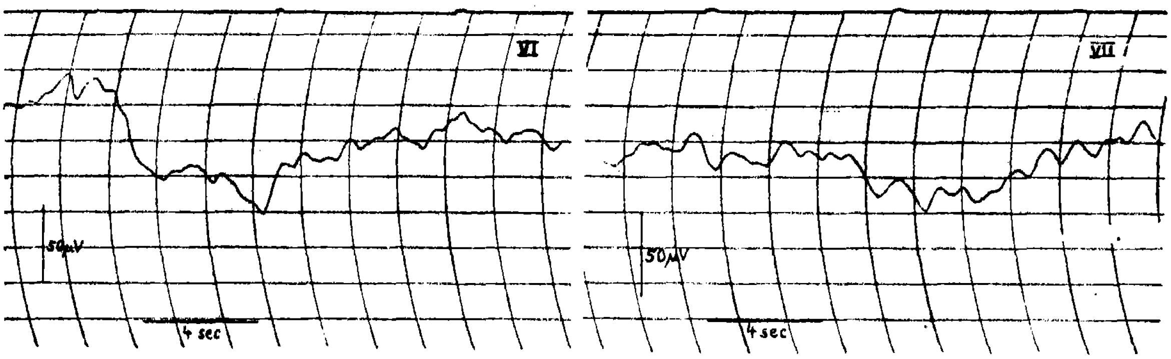

FIG. 4. Records VI and VII, subject M, asymmetrical responses with movements in opposite directions.

If the faster oscillations of Record V are alpha waves (or modified alpha), they represent, of course, one phase of what the cortex is actually doing while an object moves across the field. Strictly speaking, it would therefore seem desirable always to allow these oscillations to appear in our records, and thus to use a galvanometer, the response time of which is short enough for the purpose. We have nevertheless taken many records with our slower galvanometer (response time 0.5 sec), because the behavior of the slower potentials is sometimes more strikingly revealed when they are not covered with alpha. The following records, excepting XI, are taken with this instrument. After all, most records of alpha are taken under conditions which virtually eliminate the steady potentials of the brain. The fact that the slow instrument must also slightly distort steadier potentials can be ignored in a first exploration, which is not yet concerned with details.

Only a small central zone of the human retina seems to be represented in the parts of the visual cortex which lie, on both sides of the median fissure, directly under the skull. But localization within this zone is assumed to be specific; retinal cells on the left side of the central meridian are connected with cortical tissue in the left hemisphere, and cells on the right side with tissue in the right hemisphere. Just the opposite relations obtain, of course, between positions of outside objects and the locations of their cortical counterparts. We tried to decide whether the behavior of the currents here under investigation agrees with such facts. For this purpose, the occipital electrode was placed slightly to the right or the left of the median plane, while the second electrode remained attached to the region of the vertex. It seemed possible that the moving object would affect the occipital electrode more strongly when its cortical counterpart moved in the hemisphere corresponding to this electrode's position. We were thus led to the following four tests.

Records VI and VII (Fig. 4): In both tests the occipital electrode is placed on the right side of the median plane. With a movement of the object from left to right, i.e., retinally from right to left, the first half of the record ought to show a stronger response (VI). With the opposite direction of the movement, this asymmetry must be reversed (VII). Records VIII and IX (Fig. 5): In both tests the object moves left to right, i.e., retinally from right to left. With the occipital electrode on the left side of the median plane, the second half of the record must show a stronger response (VIII). With the electrode on the right side, the opposite must happen (IX). In such experiments, responses are expected to show a more specific shape, in spite of disturbances, and in spite of the fact that the impedance of the skull may vary from one part of the crucial region to another. We have nevertheless often obtained the predicted results. Records VI–IX may serve as examples. The asymmetries agree with our predictions.

One can go still farther in the same direction. If both electrodes are placed in the crucial occipital region, one on the left, and the other on the right side of the median plane, the cortical counterpart of the visual object will move first nearer one electrode, and then nearer the other. Under these circumstances, the resulting records ought to be diphasic; two deflections in opposite directions ought to follow each other. The difficulties inherent in such experiments are still greater than those involved in experiments VI–IX: visual potentials must be much weaker when the electrodes are placed so near each other, and responses will seldom appear to be convincingly diphasic if the curves in question show a major drift. Nonetheless, results are sometimes perfectly clear. For instance, in Records X and XI (Fig. 6), taken when the object moved from the right to the left, and when the left electrode was "active," a positive (downward) deflection during the first part of the exposure is followed by a negative deflection in the second half. With the connections used in our experiments, this is the expected sequence. The deflections are, of course, quite small (cf. the calibration).

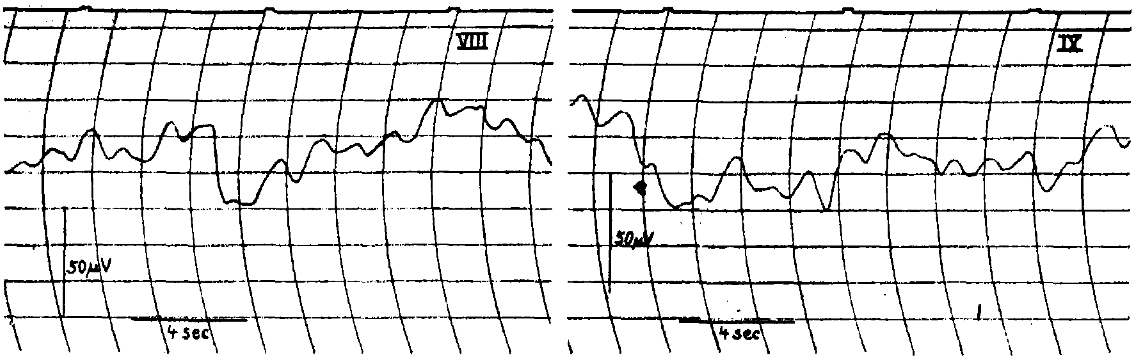

FIG. 5. Records VIII and IX, subject S, asymmetrical responses with different positions of the active electrode.

All our records have this in common: they seem to show that active parts of the visual area are surface-positive in relation to less active parts of the cortex; and that, therefore, when bright objects appear in the visual field the cortex is pervaded by currents which flow in corresponding directions. Libet and Kahn, Jr. recently obtained relatively steady potentials from other regions of the cat's cortex, but found no such responses in the visual area when the eyes were stimulated (*9*). We do not know what conditions of stimulation were used in these experiments. The negative result would contradict our findings only if the authors had also worked with moving objects of very moderate brightness.

In the meantime, the question arises whether our records are actually related to visual facts as such. It might, for instance, be suggested that such responses merely accompany eye movements, or that they represent psychogalvanic reflexes. Comparison with records obtained during eye movements and with the known characteristics of psychogalvanic reflexes has led us to the conclusion that these suggestions are not acceptable. Professor Gerard has called our attention to the possibility that vascular reactions might be associated with cortical fields. Obviously, this possibility will have to be examined; but, at the present time, the electric phase of vascular reactions does not seem to be sufficiently known for the purpose.

If the responses of our records should prove to be visual currents, our next question would refer to the origin of these currents in the visual system. As a radical answer, it might be held that responses such as these need not be interpreted in terms of steady potentials; when registered with a slowly reacting instrument, synchronized nerve impulses of considerable frequency would give similar curves. We hesitate to follow this interpretation. There is no question that, after Berger's discovery of alpha, numerous attempts have been made to find electric oscillations which accompany vision. The instruments used in such experiments have generally been well adapted to the purpose. If synchronized nerve impulses (or, rather, their fields) actually spread through skull and scalp while we see, the fact would probably have been discovered years ago. To be sure, further tests may be desirable.

It seems to us a more plausible assumption that the currents of our records represent the fields of impulses which are thoroughly nonsynchronized. It has been argued that if, from each part of a bright retinal image, nonsynchronized impulses arrive in a corre-

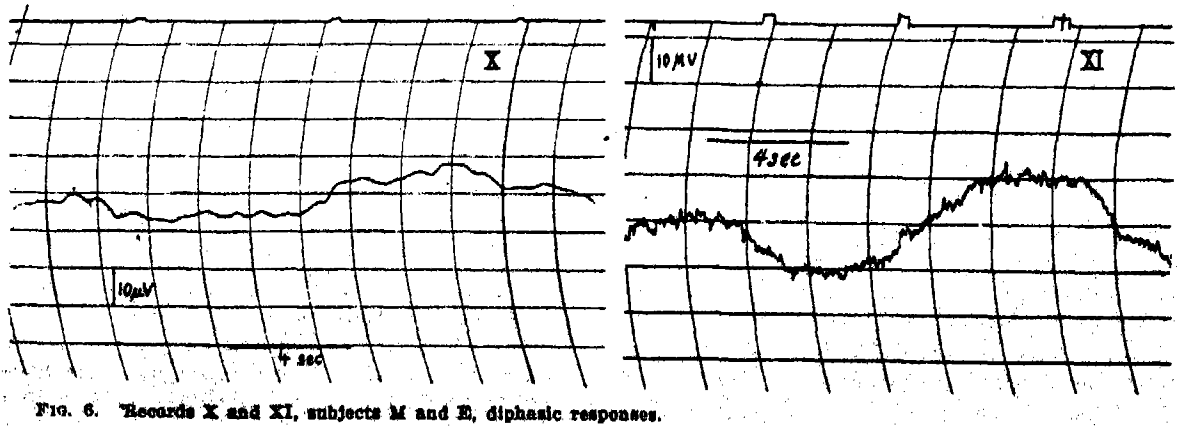

FIG. 6. Records X and XI, subjects M and E, diphasic responses.

sponding part of the visual cortex, the statistical result would be an approximately steady potential and an equally steady flow through and around the cortical counterpart of the image. If this is otherwise good reasoning, we have no cause for objection. The conclusion agrees with our own thesis. Elsewhere, we have given a derivation of steady potentials in the visual area, which refers to the much debated chemical action of nerve impulses (*5, 6, 7*). We need not choose between these two possibilities; the distribution of the resulting flow would be about the same in both cases, and this, from a psychological point of view, is the main issue.

More generally speaking, our results must be interpreted with some caution, just because they are related to important problems. The occurrence of direct currents in the cortex would probably have consequences in various parts of neurophysiology. In psychology, access to the cortical correlate of pattern vision would immediately affect the theory of psychophysical relations—and would affect first of all, the theory of perceptual space.

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TECHNICAL PAPERS

The Mutagenic Mode of Action of Formalin

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In 1946 Rapoport (*5*) reported that formalin, when mixed with the food of *Drosophila melanogaster* in sublethal concentrations, produces a high frequency of mutations. In the one experiment for which full data were given, the percentage of induced sex-linked lethals was 5.92. Kaplan (*2*) confirmed this finding, and similar results were obtained in this laboratory with a wild-type (OrK) stock. Rapoport attributes the mutagenic effect of formalin to a chemical reaction between the chromosomes and the CO group of the aldehyde. It seems rather unlikely that formalin as such would reach the chromosomes of the germ cells under the conditions of these experiments. Two other possibilities have to be considered. First, formalin might react with the food to produce a new mutagenic compound. Since formalin is added to the food while the agar is still well pourable, this reaction would take place at a temperature of about 60° C. Second, it also seems possible that a mutagenic substance is formed not in the food, but in the body of the fly either during digestion or in the germ cells.

In order to obtain information on this point, the effect of formaldehyde vapor on *Drosophila* was tested. A positive result with this method would prove that formaldehyde as such is a mutagen, which would make it at least probable that it is the effective agent in the feeding experiments also. A comparison of the effects of formaldehyde vapor on male and female germ cells in various stages of development should help to decide whether the action on the chromosomes is direct or mediated by the cytoplasm; for in the latter case female germ cells and spermatogonia should be more affected than mature spermatozoa. The OrK stock which had given 3–6% sex-linked lethals in previous feeding tests with formalin was used. Young adult ♂♂ and ♀♀ were exposed to formaldehyde vapor in the first series. Exposures lasted from 30 to 60 min, and the biologically effective dose was measured roughly by the survival rate during exposure and the first few hours afterwards. This does not take account of the fact that flies often die during the subsequent days. In all tests, ♀♀ survived in a larger proportion than ♂♂. In order to test germ cells which at the time of exposure had been at different stages of development, the treated ♂♂ were given fresh ♀♀ every fifth day, the treated ♀♀ were put on fresh food every fifth day, and mutation rates were recorded separately for the different broods. The untreated mates for both sexes were taken from the Muller-5 stock. Table 1 gives a short summary of the results.

The OrK stock used for these experiments has been tested repeatedly over the past few years. Sex-linked lethals in the ♂♂ arise at a fairly constant rate of about

0.3%. It is obvious that the treatment has remained ineffective, and that at doses which allow about 50% of the ♂♂ and about 75% of the ♀♀ to survive, formaldehyde neither reacts with the chromosomes directly to produce mutations nor with the cytoplasm of the germ cells to produce a mutagenic substance.

TABLE 1

THE EFFECT OF FORMALDEHYDE VAPOR ON MUTATION RATE IN GERM CELLS OF IMAGINES

Sex	Survival rate	No. of tested X-chromosomes	No. of lethals	Percent of lethals
♂♂	43/60	1172	1	
	7/24	451	0	
	13/28	983	3	
		2606	4	0.2
♀♀	22/28	1136	0	
	21/28	1342	1	
		2478	1	0.05

Since it seems legitimate to consider the experiments as tests for spontaneous lethals, an interesting incidental result consists in the confirmation of two previously reported features of the spontaneous mutation rate. First, the mutation rate is higher in ♂♂ than in ♀♀ (*1*). Second, when the mutation rate is recorded separately for the four successive broods from treated ♂♂, the following figures are obtained: first brood, three lethals in 860 chromosomes; second and third broods, no lethals in 1543 chromosomes; fourth brood, one lethal in 203 chromosomes. This curve of mutation rate with a peak for the first sperm used and an increase for spermatozoa which have been stored for a considerable time, has been described by Lamy (*3*), and Muller (*4*).

As the feeding method only treats larvae, the negative result obtained on adults did not seem conclusive. Additional tests on larvae were carried out with a new apparatus which allowed milder and therefore longer exposures to be made. In the first experiments old larvae were used, because these can stand a fairly long exposure. However, when feeding tests, carried out at the same time, indicated a sensitive period to the mutagen early in the third instar, tests were also carried out on younger larvae of this age. These larvae can stand only a much shorter exposure without being killed or sterilized.

TABLE 2

THE EFFECT OF FORMALDEHYDE VAPOR ON MUTATION RATE IN THE GERM CELLS OF LARVAE

Time in hr after laying of eggs	Length of exposure	No. of tested X-chromosomes	Lethals	
			No.	%
96–100	2 hr	2126	2	0.1
about 70	2 hr	138	0	0
46–56	2 hr	169	1	
	70 min	408	1	
	50 min	436	1	
		1013	3	0.3

In all tests, a considerable proportion of the larvae died either during exposure or later on. The two sexes had the same survival rate. Table 2 summarizes the data gained from exposure of larvae.

In all series, the results are negative. Thus, all attempts to induce mutations by formaldehyde vapor have failed, and it seems most likely that the effective mutagen is a compound formed by reaction of formaldehyde with one of the components of the food. Experiments to identify this component have been started.

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Inhibition of Phosphatases by Beryllium and Antagonism of the Inhibition by Manganese

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Beryllium poisoning has become a subject of considerable practical importance as a result of the use of beryllium compounds in the fluorescent light industry and in several other industrial processes. The occurrence of a number of cases of beryllium poisoning as a result of the industrial use of this metal has emphasized the necessity of obtaining detailed information on the toxicity and mode of action of beryllium in mammals. While numerous studies have been carried out on the toxicology of beryllium, little is known of its mechanism of action and no therapeutic measures for either acute or chronic beryllium poisoning are available.

In undertaking studies on the mechanism of action of beryllium, we were interested in examining its effect on enzymatic reactions with special attention being directed toward enzymes requiring metallic activators. The occurrence of beryllium in the same atomic group with calcium and magnesium and the many similarities in the chemical behavior of these three metals suggested that the toxic effects of beryllium might involve interference with the biological functions of calcium and magnesium. The present communication describes the results of experiments which demonstrate that beryllium inhibits alkaline phosphatases activated by magnesium and calcium, and that this inhibition can be prevented and reversed by manganese.

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[1] The work described in this paper was conducted at the University of Chicago Toxicity Laboratory under a research contract supported by the Atomic Energy Commission and administered through the Medical Division, Chemical Corps, U. S. Army. Under the terms of the contract neither the Atomic Energy Commission nor the Army Chemical Corps is responsible for the opinions or conclusions of the authors.

In order to ascertain the action of beryllium on a calcium-activated enzyme, the adenosine triphosphatase system was employed, and the effect of beryllium on the adenosine triphosphatase activity of mouse liver and lung tissue was measured by the method of DuBois and Potter (2). For all of our tests, aqueous solutions of beryllium chloride were employed. The inhibitory action of beryllium on adenosine triphosphatase activity is shown by the data in Table 1, from which it may be seen that the activity of lung and liver tissue was inhibited to about the same extent by similar concentrations of beryllium.

TABLE 1

THE EFFECT OF BERYLLIUM ON THE ATP-ASE ACTIVITY OF MOUSE LIVER AND LUNG TISSUE

Tissue	Molar concn. of beryllium	ATP-ase units	% Inhibition
Liver	0	13.4	..
	6.1×10^{-3}	1.0	92
	3.0×10^{-3}	3.0	78
	8.0×10^{-4}	9.3	21
Lung	0	17.3	..
	6.1×10^{-3}	1.7	90
	3.0×10^{-3}	4.4	74
	8.0×10^{-4}	10.8	37

TABLE 2

THE INHIBITORY ACTION OF BERYLLIUM ON ALKALINE PHOSPHATASE OF RAT TISSUES

Tissue	Phosphatase activity mg P/g tissue/hr	Molar concn. of Be for 50% inhibition
Serum	0.33	1.8×10^{-6}
Duodenum	34.20	5.0×10^{-6}
Kidney	32.6	5.9×10^{-5}
Lung	1.78	4.5×10^{-4}
Brain	0.72	5.9×10^{-4}

In view of the inhibitory action of beryllium on adenosine triphosphatase activity, we were interested in testing the effect of beryllium on magnesium-activated phosphatases. The similarity in the chemical behavior of magnesium and beryllium was first observed in 1888 by Sestini (5) who found that beryllium could replace magnesium in the growth of plants. Recently Grier, Hood, and Hoagland (3) and Klemperer, Miller, and Hill (4) have demonstrated that beryllium exerts a strong inhibitory action on alkaline phosphatases. To compare the inhibitory action of beryllium on phosphatases activated by magnesium and calcium, we have examined the effect of beryllium on the alkaline phosphatase activity of several tissues. Alkaline phosphatase measurements were performed using essentially the method of Bodansky (1) with modifications in the quantities of reactants to make the method suitable for small quantities of tissue. The test system contained 1 ml of 0.025 M Veronal buffer (pH 8.9) containing 0.015 M sodium β-glycerophosphate, 1–100 mg of homogenized tissue or serum, and enough water to make a final volume of 1.7 ml. Solutions of the various metals employed replaced an equivalent amount of water in the test system. After incubation for 30 min at 38° C, the reaction was stopped by the addition of 0.3 ml of 50% trichloracetic acid and after centrifugation the inorganic phosphate liberated was measured. Table 2 gives the alkaline phosphatase activity of several tissues in the absence of added metallic ions. The values are expressed as mg of phosphorus liberated per g of tissue per hr together with the molar concentration of beryllium necessary to produce 50% inhibition of the alkaline phosphatase activity of each tissue. These results demonstrated the pronounced inhibitory action of beryllium on magnesium-activated phosphatases. There was a considerable difference in the sensitivity of the alkaline phosphatase of serum and various other tissues to beryllium, with serum phosphatases being the most sensitive of those studied.

TABLE 3

ANTAGONISTIC ACTION OF MANGANESE ON THE INHIBITION OF SERUM PHOSPHATASE BY BERYLLIUM (5.9×10^{-10} M)

Molar concn. of manganese	% Inhibition
0	77
5.9×10^{-3}	4
5.9×10^{-4}	13
2.9×10^{-4}	51
5.8×10^{-5}	64

It is likely that the inhibitory action of beryllium on phosphatases results from competition with magnesium and calcium for the same group on the enzyme with which they react. In this connection we were interested in ascertaining whether increasing the concentration of magnesium or addition of some other metallic ion to the system would decrease the amount of inhibition of serum phosphatase by beryllium. Various concentrations of magnesium as high as 5.9×10^{-3} M did not influence the inhibitory action of beryllium. This observation was in agreement with the results of other investigators (3). This indicated that beryllium has a much greater affinity for the enzyme than does magnesium. Since manganese also activates alkaline phosphatases, we tested the inhibitory action of beryllium on serum phosphatase in the presence of various concentrations of manganese as manganese sulfate. When manganese and beryllium were present in the test system at the time of addition of the serum, manganese markedly decreased the inhibition produced by beryllium, as illustrated by the data in Table 3. It was also found that manganese was effective in antagonizing the action of beryllium when added to the reaction mixture 5 min after the beryllium and serum were mixed. Cobalt and nickel also antagonized the inhibitory effect of beryllium on serum phosphatase *in vitro*.

The results of these experiments give support to the hypothesis that beryllium interferes in biological reactions in which magnesium and calcium participate. Magnesium-activated reactions appear to be more sensitive toward the action of beryllium than calcium-activated reactions. The extent to which the effects of beryllium on phosphatases are involved in acute and chronic beryllium poisoning must be determined by further experimentation on beryllium-poisoned animals. The ability of manganese to counteract the inhibitory effects of beryllium on phosphatases *in vitro* is encouraging because it provides evidence of the possibility of reversing the combination of beryllium with tissue constituents and thereby suggests a possible approach to the development of therapy for beryllium poisoning. In this connection, experiments are in progress at the present time in which the effects of several metals on acute and chronic beryllium poisoning are being tested. The results of these experiments will be reported in detail elsewhere.

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The Skin Temperature of an Extremity as a Measure of Its Blood Flow

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Skin temperature often is used as an index of blood flow in the extremities, even though the relation may be merely implicit. The purpose of this communication is to emphasize the fact, mentioned by Lewis (*3*) and others, that skin temperature is valid as a measure of extremity blood flow under certain conditions only.

Skin temperature depends upon both the rate of heat supply to the skin and the rate of heat removal—that is, upon the temperature and flow rate of the blood, and the insulation and temperature difference between skin and environment. If the temperature difference is small, heat will be removed so slowly that even large changes of blood flow will have little effect on the skin temperature. This is illustrated in the figures, in which are plotted finger blood flow and finger temperature against time. (Finger blood flow was measured with the plethysmographic method of Goetz (*2*) using air transmission. The values given are the averages of the flow at systole and at the end of diastole. Finger temperatures were measured with small thermocouples attached with adhesive tape, and connected to an instrument sensitive to 0.15° C and recording at 80-sec intervals. The hand was bare.) At a room temperature of approximately 32° C it is obvious from Fig. 1 that the finger surface temperature bears no relation to changes of blood flow. The correspondence is scarcely improved at an ambient temperature of about 21° C (Fig. 2). The air movement in both these experiments was the same.

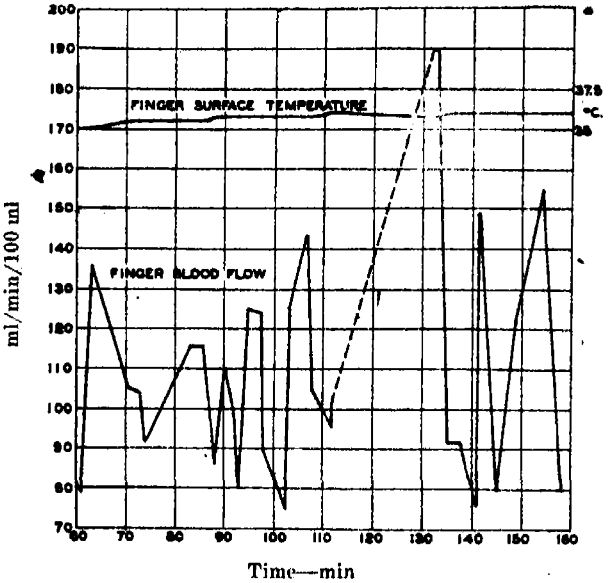

FIG. 1. Blood flow and skin temperature at 32° C ambient. Hand air insulation = 0.54 equivalent clo.

At about 7° C room temperature, with greater air movement, skin temperature follows the blood flow pattern fairly well, as can be seen in the example given in Fig. 3. At −34° C, with a gradient of 55–66° C between the bare hand and the ambient air, the lag between blood flow change and skin temperature change is probably negligible; for example, a very minor emotional disturbance may cause a fall of finger temperature of 8° C within 2 min; or a few deep breaths, of 3° C.

Our experience, exemplified by the figures, is that the heat loss rate calculated for the hand should be 12 kg-cal/hr (240 kg-cal/hr/m^2) or more, if the skin tempera-

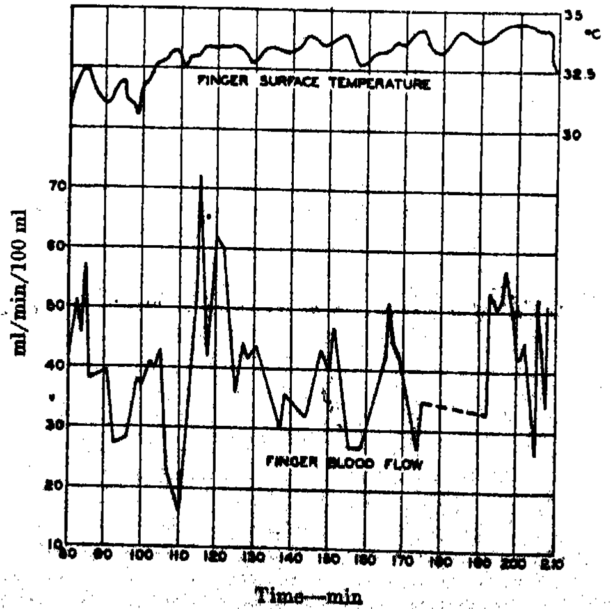

FIG. 2. Blood flow and skin temperature at 21° C ambient. Hand air insulation = 0.54 equivalent clo.

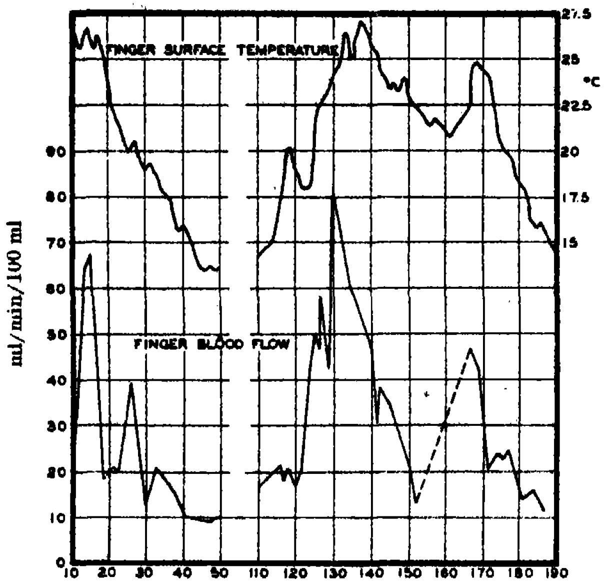

FIG. 3. Blood flow and skin temperature at 7° C ambient. Hand air insulation = 0.30 equivalent clo.

ture is to follow closely the blood flow changes. It is likely that this approximate minimum applies to other areas of the body. This heat loss rate corresponds, for example, to an air insulation over the bare hand of 0.54 equivalent clo[1] (insulation unit) and a temperature difference of 24° C between hand and air; or to a temperature difference of 13° C if the air insulation is 0.30 equivalent clo.[2] Thus, if the temperature of the hand is expected to fall to 21° C the ambient temperature should be −3° C; or 8° C for the higher air movement. If only gross, slow changes of blood flow are to be measured, correspondingly lower heat loss rates may be adequate.

Good blood flow rates may be achieved in normal persons even with high gradients, provided that only the part under investigation is exposed to the cold, and the rest of the body is warm. This can be done by insertion of, say, the extremity of a nude subject into a cold box in a warm room; or by exposure to a cold room of the extremity of a warmly dressed subject. It is true that minute variations of temperature can be measured with high sensitivity apparatus, and that these, with some lag, might represent blood flow more exactly than do the examples given. Such a technique has serious drawbacks, and it would appear advantageous to apply the laws of heat transmission in order to amplify and accelerate temperature changes.

In summary, if direct measurement of blood flow is not feasible, and skin temperature is used instead, the part of the body under investigation must lose heat at a rate of more than about 240 kg-cal/hr/m² for good correspondence between blood flow and skin temperature changes. If local cold stimulus must be avoided, a flow method must be employed.

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[1] The clo equation is not strictly applicable to a portion of the body, having been derived for the body as a whole (*1*).

[2] Recent determinations with an electrically heated manikin give an insulation of the air around the hand of 0.54 equivalent clo when that of the whole body is 0.82 clo; and of 0.30 equivalent clo when the average for the body is 0.48 clo.

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The Action of Penicillin on *Bacillus subtilis* Growing in the Absence of Amino Acids[1]

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Gale and his co-workers (*2*) have reported that Gram-positive bacteria are able to assimilate glutamic acid from the medium in which they are grown and to concentrate the free amino acid within the bacterial cell. Gram-negative organisms, on the other hand, appear to be unable to do so. They further observed that when certain strains of *Streptococcus faecalis* and *Staphylococcus aureus* were exposed to penicillin during the logarithmic phase of growth, the ability to concentrate free glutamic acid in the resting cell was lost. Subsequently Bellamy and Klimek (*1*) noted that a strain of *Staphylococcus aureus* which had been trained to grow in extremely high concentrations of penicillin changed from its usual morphology to that of a Gram-negative coccobacillus and acquired the ability to grow in a medium containing no amino acids. Gale (*2, 3*) also found that a strain of *Staphylococcus aureus* trained to grow in a medium deficient in amino acids, acquired *pari passu* a considerable degree of penicillin resistance. He therefore suggested that "penicillin interferes with the mechanism whereby certain amino acids are taken into the cell, and that the sensitivity of the cell to penicillin is then determined by the degree to which its growth processes are dependent upon assimilation of preformed amino acids rather than upon their synthesis."

At least two objections may be raised to this hypothesis. In the first place, some of the Gram-negative coliform organisms are inhibited by high concentrations of penicillin, and yet most of them require no amino acids for growth (*7*). Secondly, *B. subtilis*, a Gram-positive organism with many strains sensitive to penicillin, has been reported in some instances to grow in media containing only ammonia as a source of nitrogen (*5*).

A search was therefore made for strains of *B. subtilis* which would grow in a synthetic medium devoid of amino acids in order to determine whether such strains would be inhibited by penicillin.

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[1] This investigation was supported by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service.

The first few strains investigated grew readily in various synthetic media deficient in amino acids, and under certain conditions were completely inhibited by penicillin. Irregular results were obtained, however, and it eventually became apparent that these could be attributed to the production of penicillinase by the organisms.

A strain of *B. subtilis* (PCI-220-NNRL-B-558) (*6*) was finally obtained which did not produce penicillinase and which grew readily in a synthetic medium, "Base B" (Table 1), containing only ammonium sulfate as a source of nitrogen. In this medium the organism was just as sensitive to penicillin as it was in a "complete" medium (tryptose phosphate broth) irrespective of wide changes in the age of the culture, the size of the inoculum, and the time of reading. (See Table 1.)

TABLE 1

PENICILLIN SENSITIVITY OF *Bacillus subtilis* (PCI-220-NNRL-B-558)

Medium	Inoculum 18-24-hr culture in B.B.		Time of reading in hr	Inhibiting concentration of penicillin u/ml
	Amount and dilution	Approximate no. of viable organisms		
T.P.* broth ..	.2ml 10^{-1}	2×10^4	18	.008
			90	.008
	.2ml 10^{-5} (unwashed)	20	18	.008
			90	.008
B.B.†	.2ml 10^{-1}	10^5	20	.008
			96	.008
	.2ml 10^{-4} (washed)	10	20	.008
			96	.008
T.P. agar	.2ml 10^{-1}	2×10^4	18	.01
			90	.05
	.2ml 10^{-4} (washed)	6×10^2	18	.01
			96	.01
B.B. agar	.2ml 10^{-1}	10^5	20	.01
			96	.01
	.2ml 10^{-4} (washed)	10	20	.01
			96	.01

* Tryptose phosphate.

† "Base B," composition as follows, wt/liter of medium: KH_2PO_4 – 4.5 g; NaOH – 1.1 g; Fe $So_4 - 7H_2O$ – 0.0139 g; Mg SO_4 (anhyd.) – 0.02 g; $(NH_4)_2SO_4$ – 0.73 g; glucose – 2.25 g (autoclaved separately); sodium thioglycolate – 0.27 g; thiamine (subsequently found to be unnecessary for growth) – 0.00003 g (autoclaved separately); nicotinic acid (subsequently found to be unnecessary for growth) – 0.001 g; distilled H_2O to 1000 ml. Adjusted to pH 7.4.

Determinations of sensitivity to penicillin were carried out in fluid media as follows: A known quantity of crystalline sodium penicillin G was dissolved directly in the basal medium to give an appropriate concentration. Serial dilutions were then made in 1 ml volumes so that eight tubes, containing concentrations of penicillin varying from 0.15 u/ml to approximately 0.001 u/ml, were obtained. All tubes including a control were inoculated with 0.2 ml of a culture which had been washed three times in sterile saline and resuspended in the basal medium immediately before inoculation. The tubes were incubated at 37° C and were observed at intervals for the appearance of turbidity. Growth in control tubes was usually apparent after 12 hr, and a distinct end point could be read after 18–24 hr.

Agar plates[1] were also prepared containing similar concentrations of penicillin in both the basal medium and tryptose phosphate broth. The plates were streaked with similar washed inocula and incubated at 37° C. The appearance of surface growth was noted, and inhibition was recorded only when no visible colonies occurred.

Precautions were taken to exclude amino acids from the basal medium as completely as possible. Reagent chemicals[2] were used throughout, and test tubes were acid cleaned and capped with aluminum foil.

In order to determine whether or not this organism elaborated significant amounts of amino acids into the basal medium, a chemical method for the detection of amino acids was employed. By using a modification of the ninhydrin method of Moore and Stein (*4*) it is possible to detect concentrations of glutamic acid smaller than 1 μg/ml added to the basal medium. Excepting proline and hydroxyproline, all of the amino acids as well as ammonia, peptides, and many amines form a colored product with ninhydrin showing an absorption peak at 570 mμ. If the basal medium is aerated for 5 hr at pH 11.5, most of the ammonia is driven off. After neutralization the solution may then be treated with ninhydrin and the color measured with a spectrophotometer at 570 mμ. When this method was employed, the basal medium, thought to be free of amino acids, was found to give a blank value equivalent to that obtained with 0.5–1.0 μg/ml of glutamic acid. It seems likely that most of this color was actually due to residual ammonia, and in any event the value obtained sets an upper limit for possible traces of amino acids in the medium.

In an experiment in which a washed inoculum of this strain of *B. subtilis* was grown in the basal medium for 24 hr, samples of the culture were removed at 6-hr intervals for the following determinations: turbidimetric reading, dry weight of organisms, count of viable organisms, and concentration of ninhydrin-reacting substances in the aerated filtrate. During the first 12 hr, when maximum growth took place, there was no demonstrable increase in ninhydrin-reacting substances in the filtrate, although at 18 and 24 hr, with slowing of growth and death of organisms, small amounts appeared.

After 18-hr incubation there were 200 μg of organisms by dry weight in 1 ml of culture. Since there was no more than 1 μg of amino acid/ml present in the basal medium originally, and since dried bacteria contain an average of 60% protein (*5*), it is apparent that less than 1% of the protein synthesized during growth could be accounted for by amino acids assimilated from the medium.

It is concluded, therefore, that penicillin inhibits the growth of this particular strain of *B. subtilis* by some mechanism other than interference with the assimilation of preformed amino acids by the bacterial cell.

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[1] The agar was washed 5 times overnight in distilled water.

[2] Except for Difco sodium thioglycolate.

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A Source of Error in Tracer Experiments with P^{32} [1]

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In dealing with radioactive solutions of high specific activity where total phosphorus is small, the amount of P^{32} adsorbed on laboratory glassware may become significant.

An experiment done in this laboratory to measure this adsorption and to determine the efficacy of silicone-coated glassware illustrates the magnitude of the problem.

A solution of P^{32} containing about 1×10^{-4} mg /ml of total phosphorus was drawn up once into each of four 2-ml pipettes, all new and identical except that two had been coated with silicone. Each of the pipettes was then washed by drawing up 2-ml amounts of distilled water. The wash water from each pipette was collected into two counting sample cups (1 ml each), evaporated, and the number of radioactive disintegrations determined in a Nucleometer.

Average values, in cpm/ml were:

	Coated	Uncoated
Wash 1	390	6,000
Wash 2	110	300
Wash 3	background	110

The count in the first wash of the uncoated pipette is high and variable, depending on both the P^{32} and P^{31} contents, and can cause serious error where it is not suspected.

To avoid this difficulty, we have adopted several techniques. Wherever possible all counting solutions contain a uniform 1 mg/ml of carrier phosphorus at pH 4.5. Where less carrier must be used, care is taken to pipette as rarely as possible and only in solutions containing as much carrier as the procedure permits. When conditions are extremely unfavorable, requiring exceedingly low carrier or high pH values, silicone coating of glassware is necessary.

The coating technique we used was modified from Johannson and Torek (*1*). A 2% solution of ''DC 200'' was prepared in pure grade CCl_4 (the Dow Company recommends chlorinated organic solvents). The glassware, preferably new, is scrupulously cleaned and heat-dried, completely immersed in the silicone solution, and carefully drained. It is then placed into an oven at 90° C for 2 hr, to evaporate the solvent. The temperature is then raised to 250° C for a period exceeding 4 hr but not longer than overnight. Detailed experiments on the lasting qualities of this type of coating have been done by the Dow Company. This treatment caused no detectable change in calibration.

There is another group of compounds which have been similarly used, called ''silanes'' (hydrochlorides of unpolymerized silicones). These may be vaporized onto a glass surface, where they react with the film of moisture to form a silicone layer. This process of hydrolysis and polymerization is somewhat difficult to control.

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Free Amino Acids and Peptides in Frog Embryos

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Relatively large quantities of free amino acids have been detected by two-dimensional paper chromatography in tissues of the mouse (*3, 4*), the human, and the frog (*Rana pipiens*). Each of the normal adult tissues examined appeared to have a distribution of free amino acids characteristic for that tissue. Therefore, it was apparent that the ability of these tissues to maintain the characteristic distributions of these constituents must have arisen at some time during embryonic or postembryonic development.

As the first step in the study of the free amino acids of frog tissues at various stages of development, examinations were made of alcohol extracts of material ranging from ovarian eggs to larvae, corresponding to stages 0, 1, 2, 8, 10, 12, 17, and 21 according to Shumway (*5*). In the last stage examined, there was still no intake of food from the environment. Exactly 260 mg of fresh weight of material was placed in ethyl alcohol, the final concentration of alcohol being 70–73%. The material was homogenized in a ground glass homogenizer, centrifuged, and the supernatant fluid decanted and evaporated to dryness. The residue was thoroughly extracted with 8 ml of distilled water. This was then dialyzed against 10 ml of distilled water in a rocking dialyzer (*2*). One half of the dialyzate was evaporated to dryness and placed on paper for chromatography (*1*), and the other half was chromatographed after hydrolysis with 6 N HCl.

In none of the stages studied were there detectable quantities of free amino acids in the extracts. Several ninhydrin-reactive materials were located at spots which disappeared on acid hydrolysis, and which did not correspond in position to any known amino acids. These were probably peptides which gave rise to the small quantities of aspartic acid, glutamic acid, glycine, and alanine which were detected in most of the samples after acid hydrolysis. The quantities of glutamic acid were greater than those of the other amino acids in the hydrolyzates.

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[1] Research carried out at Brookhaven National Laboratory under the auspices of the Atomic Energy Commission.

These results indicate clearly that the ability to maintain the relatively high content of intracellular amino acids of the adult frog must appear at some time after the last stage of development examined in the present study.

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The Interaction of Antimalarials with Nucleic Acids[1]

I. Acridines

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II. Quinolines

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From studies of the physicochemical factors which are of possible importance in the therapeutic activity of antimalarials, we have secured data on the ionization exponents of quinoline and acridine derivatives (*8–10*), and have reported briefly on the interaction of these compounds with plasma proteins (*11*). The present preliminary report on the interaction of these agents with nucleic acids is of interest not only from the standpoint of the possible relationship to antimalarial activity, but also because such interactions provide a plausible basis for explaining the effect of ribonucleic acid in reversing the inhibition by acridines of the growth of certain bacteria (*12, 13*), yeast (*14*), and bacterial viruses (*5, 6*). In addition, these studies provide procedures which may be useful in investigating the structure of nucleic acids and the action of the nucleases.

Yeast ribonucleic acid from the Schwarz Laboratories was purified by the procedure of Fletcher *et al.* (*7*) and Vischer and Chargaff (*19*), particular attention being paid to removal of inorganic salts by dialysis because of the large effect of ionic strength upon the interaction. Microanalysis of a sample dried at 110° C gave: N (Dumas) 16.1%; P (Pregl-Lieb) 8.8%.

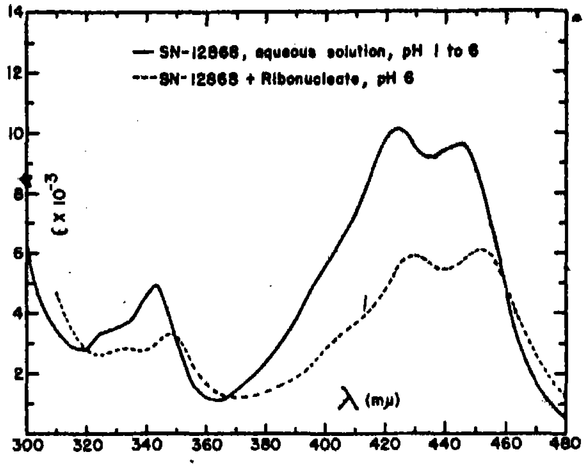

FIG. 1. Absorption spectra for SN-12868.

In Fig. 1, absorption spectra are presented for 2-methoxy-6-chloro-9-(1′methyl-8′-diethylamino-octylamino)-acridine (SN-12868)[2] in aqueous solutions buffered with phosphate at pH 6.0 ($\Gamma/2 = 0.1$) in the absence of and in the presence of sodium ribonucleate at a concentration (0.5 g/100 ml) at which the change in absorption is complete. Half-maximum transformation at this pH and ionic strength is attained when the concentration of ribonucleate (calculated as the anhydrous acid) is 0.013 g/100 ml. The interaction is stronger at lower ionic strength, and is somewhat stronger at pH 6.4 than at pH 6.0. Similar changes in spectrophotometric absorption in the presence of nucleates are obtained with 7-chloro-4-(1′-methyl-4′-diethylaminobutylamino)-quinoline (SN-7618). That the change in absorption is an indication of some type of bond between the nucleate anion and the antimalarial has been verified in the case of the acridine by determining the effect of sodium ribonucleate on the distribution of the acridine between organic solvents and buffered aqueous solutions.

In order to evaluate the interaction more exactly, we have used an adaptation of the mathematical treatment of the ionization of polyvalent acids proposed by Simms (*18*) and by von Muralt (*16*). A maximum number, m, of quinoline or acridine ligands can combine with one molecule of nucleic acid, the nucleic acid being present in a total molar concentration, T^*. For the special case in which the interacting groups in the polyvalent molecule are identical, and electrostatic interference between successively bound ligands is negligible, the binding reaction can be treated as if it consisted of the combination of one molecule of ligand per molecule of monovalent nucleic acid of total molar concentration, T, with $T = mT^*$. The process is represented as

$$N + L \rightleftarrows NL \tag{1}$$

An association constant, k', is defined by the equation:

$$k' = \frac{[NL]}{[N][L]} \tag{2}$$

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[1] Supported in part by a grant from the Penrose Fund of the American Philosophical Society.

[2] These are the code numbers employed in the publication, *A survey of antimalarial drugs, 1941–1945*, F. Y. Wiselogle. Ann Arbor, 1947.

in which brackets are used to represent molar concentrations at equilibrium, N is the free monovalent nucleic acid, L is the free ligand, and NL is the complex consisting of one monomeric molecule of ligand combined with one reacting center on the nucleic acid, this center being considered as if it were a separate monovalent molecule. The constant, k', is the intrinsic constant for the special case defined above. This constant can be evaluated spectrophotometrically essentially as described by Clark *et al.* (*1, 17*) for the interaction of nitrogenous bases with metalloporphyrins. The equation is:

$$-\log [N] = -\log \left[T - \frac{S(D_1 - D)}{(D_1 - D_2)} \right] = \log k' + \log \frac{D - D_2}{D_1 - D} \qquad (3)$$

in which S is the molar concentration of total ligand which is kept constant during the series of measurements; D_1 is the optical density of the solution when nucleic acid is absent, D_2 is the optical density when the concentration of nucleic acid is sufficiently large to cause complete binding of the ligand, and D is the optical density at some intermediate point at which both species L and NL are present.

Inasmuch as Michaelis and Granick (*15*) have suggested that the polymerized forms rather than the monomeric species of certain basic dyes, such as methylene blue, interact with polyvalent anions of the chondroitin sulfate type (but presumably not with nucleate anions according to these authors), it was desirable to formulate the possible combination of N with L_2, the dimeric species of ligand. The processes would be:

$$L_2 \rightleftharpoons 2L; \; N + 2L \rightleftharpoons NL_2 \qquad (4)$$

An association constant for the latter process can be expressed as:

$$k' = \frac{[NL_2]}{[N][L]^2} \qquad (5)$$

$$-\log [N] = -\log \left[T - \frac{S}{2} \left(\frac{D_1 - D}{D_1 - D_2} \right) \right] = \log k' + \log \frac{2S(D - D_2)^2}{(D_1 - D)(D_1 - D_2)} \qquad (6)$$

In order to compare the data for SN-12868 with that for SN-7618 on the same graph, it is convenient to define a degree of dissociation, $\alpha \equiv [L]/S$. Equations (3) and (6) then take the form of (7) and (8), respectively:

$$-\log [N] = -\log [T - S(1 - \alpha)] = \log k' + \log \frac{\alpha}{1 - \alpha} \qquad (7)$$

$$-\log [N] = -\log \left[T - \frac{S}{2}(1 - \alpha) \right] = \log k' + \log \frac{2S\alpha^2}{1 - \alpha} \qquad (8)$$

The values of T can be calculated for each equilibrium position provided that the molecular weight of the nucleic acid (from which T^* is calculated) and the value of m are known since $T = mT^*$. The molecular weight of the preparation which we have used is unknown. Nevertheless, valuable preliminary tests of the relationships given above can be made by expressing the total concentration of nucleic acid in terms of the gram-atoms of nucleic acid phosphorus per liter of solution (P). The values of T^* and T are related to P by the equation:

$$T = mT^* = mP/p \qquad (9)$$

in which p is the number of phosphorus atoms per molecule of nucleic acid. Although absolute values of m and p cannot be calculated when the molecular weight is unknown, the ratio, m/p, can be determined from the spectrophotometric data and the percentage of phosphorus in the nucleic acid.

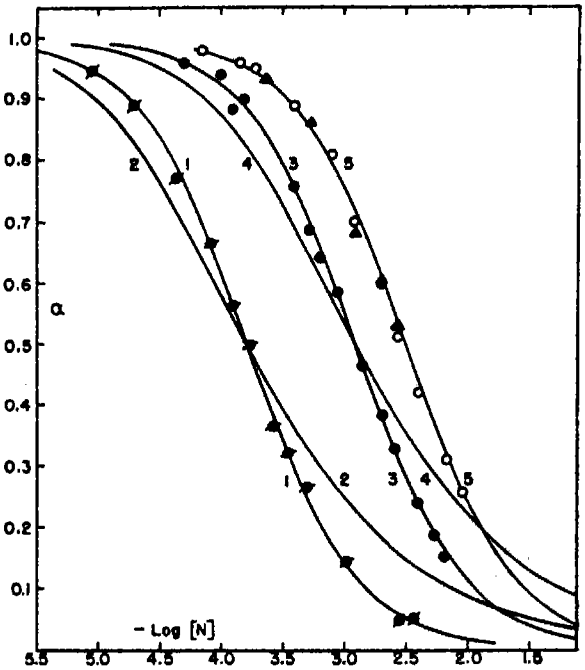

FIG. 2. Interaction of antimalarials with sodium ribonucleate at pH 5.85. -●- SN-12868: $\Gamma/2 = 0.1$; ○ SN-12868: $\Gamma/2 = 1.05$ with sodium chloride; ▲ SN-12868: $\Gamma/2 = 1.06$ with magnesium sulfate; ● SN-7618: $\Gamma/2 = 0.1$. Theoretical curves drawn according to equation (7): curve 1, $\log k' = 3.79$; curve 3, $\log k' = 2.91$; curve 5, $\log k' = 2.50$. Theoretical curves drawn according to equation (8): curve 2, $\log k' = 8.19$, $S = 4 \times 10^{-5}$ M; curve 4, $\log k' = 7.21$, $S = 5 \times 10^{-5}$ M.

In Fig. 2, data for the interaction of SN-12868 and SN-7618 with yeast ribonucleate are compared with theoretical curves drawn according to equations (7) and (8); the values of the constants are given in the legend of this figure. The values for these constants are tentative pending further work with nucleic acid preparations of proven homogeneity and known molecular weight. However, the present data permit comparison between the relative strengths of interaction of the quinoline and acridine derivatives. In both cases the interactions appear to correspond to the combination of monomeric rather than dimeric ligand with the nucleic acid. The constant for the binding of SN-12868 with the nucleic acid is approximately 7.6 times that of SN-7618 at the same pH and ionic strength.

Increase in ionic strength from 0.1 to 1.05, either by addition of sodium chloride or magnesium sulfate, produced a 19.5-fold decrease in the binding of SN-12868 by the ribonucleate anion. This suggests that the interactions of cationic acridines and quinolines with polyvalent nucleate anions involve, at least in part, the phenomenon treated theoretically by Danielli (*3*). However, the difference in binding of SN-12868 and SN-7618 suggests that forces such as hydrogen bonding and van der Waals' forces, are involved in addition to coulombic forces. The interactions reported here should be compared with those between nucleic acids and streptomycin which have been described by Cohen (*2*), and von Euler and Heller (*4*).

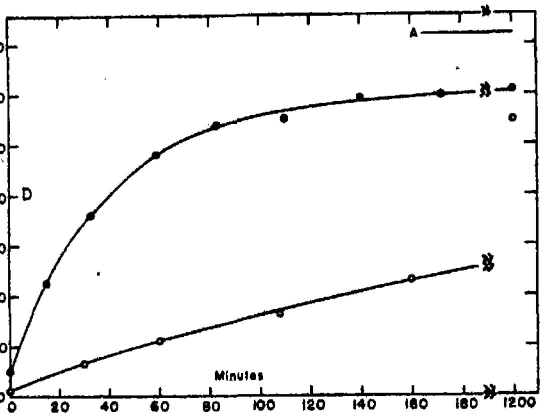

FIG. 3. Change in binding of SN-12868 by ribonucleate during incubation of the latter in 0.5 N NaOH at 24° C (●), and in 0.05 N NaOH at 37° C (○).

That the interaction of these antimalarials with nucleic acids is dependent upon the molecular size of the nucleic acids is suggested by experiments summarized in Fig. 3. Ribonucleic acid was incubated in aqueous solutions of sodium hydroxide. At intervals, aliquots of the solution were transferred to phosphate buffer, HCl equivalent to the alkali in the aliquot was added, SN-12868 was introduced, and the mixed solution was diluted with phosphate buffer in such manner that in every case the solution was 4×10^{-5} M with respect to SN-12868 and contained the equivalent of 0.046 g of ribonucleic acid per 100 ml. Final pH was 5.9 in each case. Optical densities were determined at wavelength 425 mμ. The progressive increase in optical density (Fig. 3) corresponds to progressively diminished binding of SN-12868. The rate of change in 0.5 N NaOH at 24° C was much greater than the rate in 0.05 N NaOH at 37° C, but after 20 hr the optical densities of these two solutions appeared to be approaching an equivalent limiting value, which was less than the optical density (0.394) that would have been observed in the complete absence of binding of SN-12868. The bridging phosphate ester linkages of nucleic acids undergo hydrolytic cleavage in alkaline solution, and these experiments suggest that the binding of acridine derivatives can be used as an indirect measure of such cleavage. Application of these observations in the study of the action of various nucleases is suggested.

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A Rationale for Plasma Therapy in Poliomyelitis

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During the 1948 epidemic of poliomyelitis in Los Angeles, a research program was suggested by one of us (R.M.E.), and initiated by both, in which it was observed that the serum albumin level was frequently lower than normal, and that there seemed to be a correlation between the degree of reduction and the severity of the disease. Because of the importance of serum albumin in maintaining the normal osmotic pressure of blood and of the osmotic pressure in regulating the equilibrium of tissue fluids, and because of the possibility that edema of the cord may contribute to the pathogenesis of the paralysis in poliomyelitis, the suggestion was made that a detailed study be conducted to determine: 1) the alterations in serum proteins which occur during the course of the disease, and 2) the effect on both the serum proteins and the neurologic residual of paralysis as a result of intensive administration of plasma. The results obtained were highly suggestive of a beneficial effect of plasma and will be reported in the near future, with the Los Angeles County Hospital group. It was thought desirable to describe briefly the theory that prompted the suggestion, in the hope that other workers will be stimulated to explore these therapeutic possibilities.

Because the spinal cord is encased in a bony framework, it is particularly susceptible to injury from the edema which consistently accompanies the virus-induced nerve cell damage. Any decrease in serum albumin caused either by accelerated protein catabolism or disturbed protein synthesis and occurring as one of the systemic manifestations of the disease would lower the plasma osmotic pressure and accentuate the spinal cord edema. Conversely, if the serum albumin (and osmotic pressure) were raised by the administration of plasma, the process might be reversed.

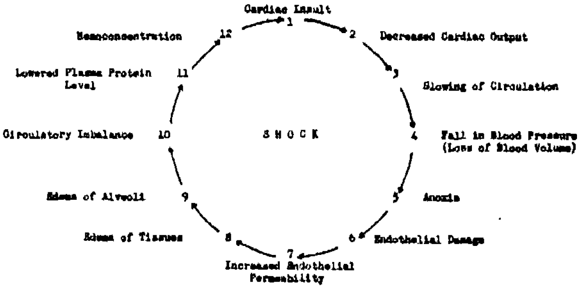

FIG. 1. It is probable that the shock state may be produced by a type of chain reaction initiated at any one of the above 12 points. Hemorrhagic shock emanates from point 4 as an actual loss of blood volume. Infectious shock would start at point 6 with endothelial damage.

In uncomplicated hypoproteinemia, the osmotic pressure of plasma proteins must be reduced to approximately 20 mm of mercury or below before edema is clinically evident. However, when factors tending to precipitate shock are operative, much more moderate decreases in plasma protein may become important in the pathogenesis of generalized or local edema. For instance, it has been shown by Eaton (*2*) that after an acute hemorrhage is induced in dogs, a degree of pulmonary edema rapidly develops which seems to be the result of a shock syndrome, in which there is a decrease in cardiac output, slowing of the circulation, drop in blood pressure, anoxia, endothelial damage, increased permeability of endothelium, transudation of fluid through the impaired endothelial structure, lowering of serum protein levels, and subsequent pulmonary edema (Fig. 1). In these experiments only a slight lowering of the already depressed serum albumin level existent in the shock state was necessary in one group of hemorrhaged dogs to accelerate significantly the accumulation of free fluid in the pulmonary tissue as compared with a control group of hemorrhaged dogs in which no added alteration of serum albumin was made. In poliomyelitis, on the other hand, it is postulated that the virus-induced infection itself may initiate a similar, although at first local, shock syndrome (infectious shock) at point 6 in the diagram, and cause damage to capillary endothelium, vascular congestion, and anoxia, and consequently lead to the transudation of fluid across the impaired endothelium and into the cord. Here again, slight lowering of the plasma osmotic pressure, caused by increased protein catabolism and disturbed protein synthesis as a systemic manifestation of the disease, could lead to a prompt increase in both the degree and the rate at which the local edema of the cord develops.

According to reports in the literature, plasma in moderate amounts has been given in the past to patients with poliomyelitis, with the idea of introducing the immune bodies of the globulin fraction. In one brief study reported by Barnum and Bower in 1944 (*1*), large amounts of plasma were intravenously administered with apparently good results, but again with the apparent intent to administer γ-globulin. The present paper suggests that the therapeutic value of plasma in poliomyelitis may more correctly be attributed to the albumin fraction and to its effect in reducing cord edema. Our preliminary results with a group of 76 Los Angeles patients, soon to be reported, are in accord with this hypothesis and indicate that generous amounts (600 to 900 ml daily) are required.

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A Photoelectric Microdensitometer

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The photoelectric microdensitometer was designed for the semiquantitative determination of colorimetric histo and cytochemical tests. Visual judgment of color intensity is not sufficiently reliable to permit comparison of the degree of color in experimental and control preparations. This instrument completely eliminates the subjective element of judging color intensities. It is possible to duplicate the values of different sets of tests (e.g. the Feulgen reaction) on comparable material within ±2%.

The microdensitometer is based on ideas from a number of sources, particularly Dempsey *et al.* (*2*), and Stowell (*3*). Although this densitometer assembly is not new in principle, its adaptability and reliability make it a valuable laboratory aid.

As shown in Fig. 1, the assembly consists of a monocular microscope, a Leitz Makam with a ground glass back, and a model 512 Photovolt Electronic Photometer with a Type C search unit. The phototube search unit is mounted in a traversing mechanism which can be used to move the search unit over the ground glass screen. This assembly in turn is mounted on an arm that can be moved up and down a vertical post. The arm is counterbalanced by a spring-activated steel tape fixed to the top of the vertical post and is provided with a collar which will lock the assembly at any height by a simple set screw. Details of the arm and traversing mechanism are shown in Fig. 2.

Illumination of the Kohler type, as described by Copeland (*1*), is provided by any good microscope lamp and

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[1] U. S. Public Health Service, National Cancer Institute Research Fellow.

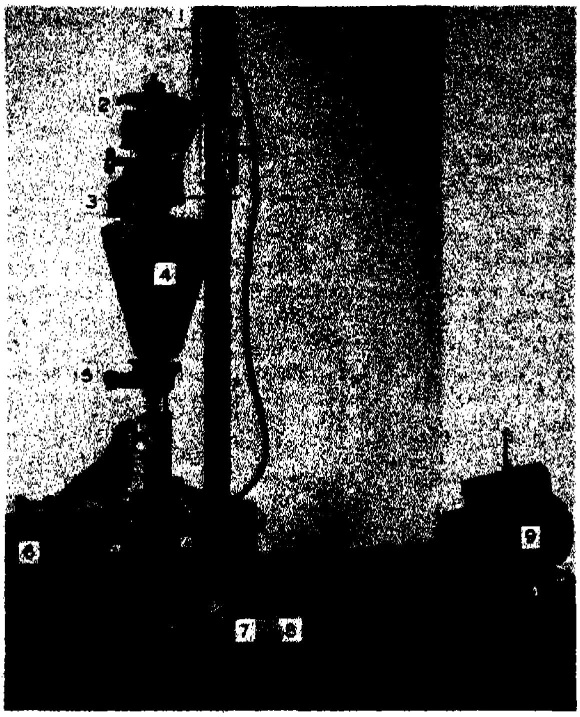

Fig. 1. *Photoelectric Microdensitometer.* 1. Spring-activated counterbalance. 2. Arm and traversing mechanism. 3. Search unit. 4. Leitz Makam. 5. Side ocular. 6. Photovolt Electronic Photometer. 7. Polaroid variable density screen. 8. Color filter. 9. Lamp housing.

may be adjusted in intensity by a polaroid variable density screen.[2] A 90° prism[3] cemented with Clarite on the flat surface of the microscope mirror converts the light reflecting system, in effect, into a first-surface mirror. This eliminates the secondary light images formed by an ordinary or back-silvered mirror.

The Leitz Makam is used because it can be mounted directly on the microscope, thereby reducing the bulk of the equipment. Furthermore, this camera is equipped with a side ocular for critically centering and focusing the material to be studied. Almost any other type of microscope camera with a ground glass back can be used.

The traversing mechanism for the phototube was made from two rack and pinion units mounted at right angles to one another (see Fig. 2). The search unit was clamped between two brass plates held together by four long screws. The lower plate was provided with an opening slightly larger than the window of the search head, allowing the use of interchangeable aperture cones which adapt the instrument for reading areas of different sizes. These aperture cones used in conjunction with low, medium, and oil immersion objectives make possible densitometric readings of large tissue areas, individual cells, and even small areas within a cell such as the nucleus.

In practice, a filter complementary to the color of the material studied was used. The light intensity was adjusted by means of the polaroid screen until the light passing through a clear area of the slide read approximately 100 on the densitometer. Then the densitometer was adjusted so that it read exactly 100. The section to be studied was then placed in the field, accurately focused, and read by recording the meter readings of specific areas of the section as the search unit (with suitable aperture cone) was placed over parts of the section as seen on the ground glass. Since the initial adjustments constitute the blank readings corresponding to 100% transmission, the subsequent determinations were read as percent transmission. Where controls give the approximate zero point of color intensity, it is possible to adjust the control reading either to 100% or 0% transmission, and then read the experimental results corrected for the controls.

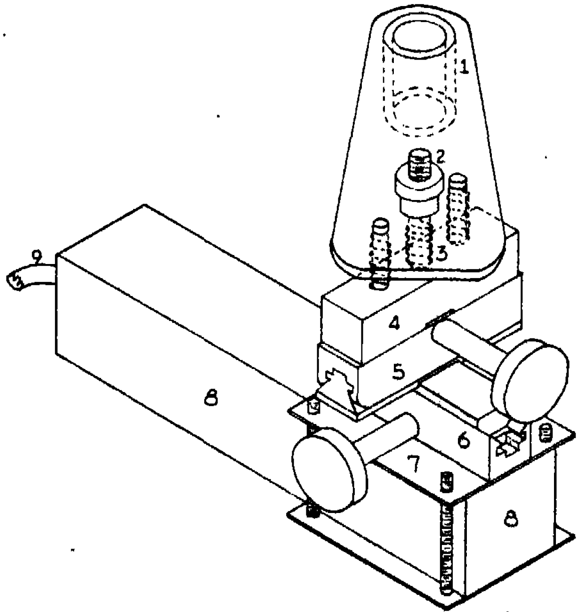

Fig. 2. Detail of arm and traversing mechanism. 1. Arm with collar. 2. Screw mechanism for raising and lowering search unit. 3. Springs. 4. Brass block. 5. Transverse rack and pinion. 6. Longitudinal rack and pinion. 7. Clamp for search unit. 8. Search unit. 9. Cord to electronic photometer.

Readings do not correspond to specific absorption as determined by spectrophotometry where transmission of individual wavelengths can be determined. They can, however, be used as an accurate estimate of the intensity of a reaction provided that experimentals and controls are prepared under exactly comparable conditions. The readings may be used to construct charts and graphs which facilitate the interpretation of results.

The photoelectric microdensitometer can be adapted for use in microchemical determinations. Depression slides may be used as microcuvettes to prepare a set of standards of known concentration for calibration of the instrument. Curves of these values may be plotted and used to determine unknown concentrations as found in densitometer readings of tissue sections, if the difference between the thickness of microcuvettes and of tissue sections is known.

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[3] Available from Army surplus material.

Remote Pipetting Apparatus for Dispensing Solutions of Radioisotopes[1]

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A remote pipetting apparatus for the handling of "hot" solutions is an essential item of equipment for most radioisotope laboratories. Although equipment for this type of operation has been reported (*1*) and is available commercially (*2*), the remote pipetting apparatus herein described is more versatile, provides truly remote operation, and can be assembled from materials more generally available in the laboratory.

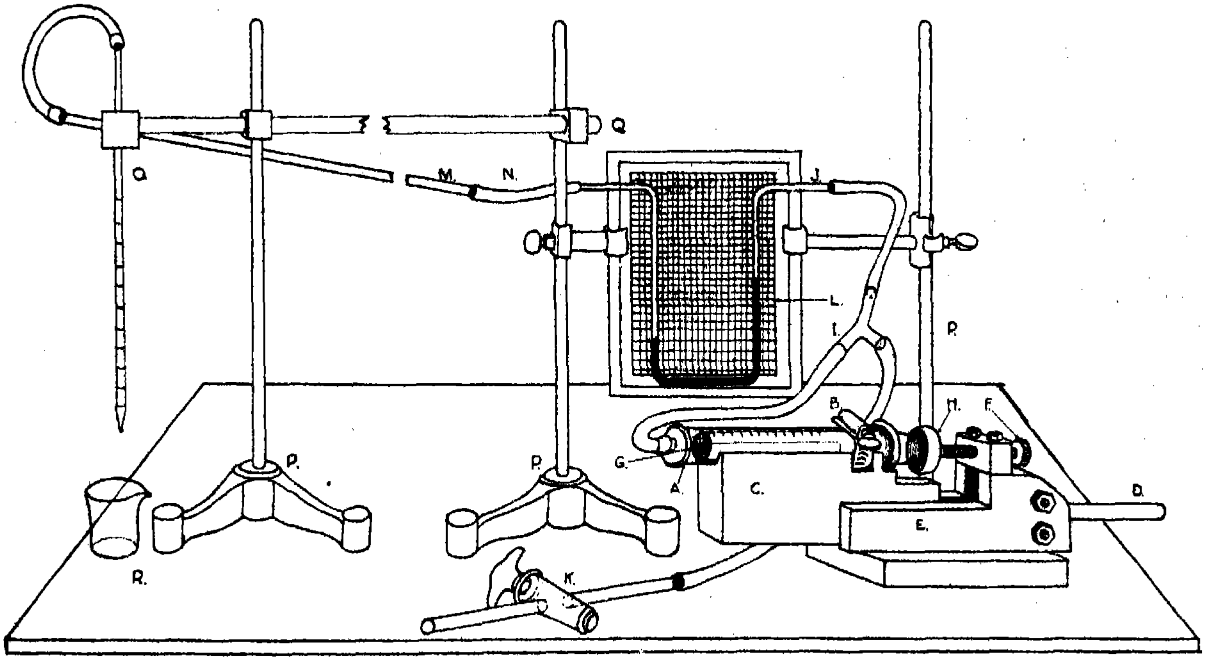

FIG. 1.

The unique feature of this apparatus is the use of a manometer for measuring the delivered volume. This manometer can be placed at the site of the operator at any desired distance from the radioactive source. Filling and delivery from the pipette are accomplished by turning a micrometer screw attached to the plunger of a syringe. The complete apparatus is shown in Fig. 1.

The main parts of the apparatus are the aluminum syringe assembly, the manometer and scale, the pipette support and arm, and the pipette. The syringe assembly consists of a syringe, *A*, (20 ml), held by a strap, *B*, in a semicircular grooved support, *C*; this support can be moved forward or backward on rod *D*, between the arms of the angle block, *E*. The micrometer screw, *F*, is connected to the syringe plunger, *G*, by means of a tubular rubber connection, *H*. The tip of the syringe is connected to a glass Y tube, *I*. One of the forks of the Y tube is connected to the manometer, *J*, the other to stopcock, *K*. This stopcock is used to adjust the level of the colored water in the manometer. One-mm cross-section paper, *L*, is mounted on a board behind the manometer. The other end of the manometer is connected to a straight length of glass tubing, *M*, by rubber tubing, *N*. The glass tubing in turn is connected to a 1-ml pipette, *O*. The supports, *P*, and the horizontal rod, *Q*, can be set at any height or length. The container or receiver, *R*, can be set behind lead bricks (not shown).

Accurate delivery over the entire range of the manometer can be obtained only by using carefully selected tubing of uniform bore for the manometer and by having

TABLE 1

VOLUMES DELIVERED FROM THREE DIFFERENT SECTIONS OF THE MANOMETER SCALE AND THE REPRODUCIBILITY OF REPLICATE SAMPLES*

Section of manometer used	Weight of water delivered	Volume of water delivered at 25° C	Standard deviation σ
	mg/100 mm	ml/100 mm	
215 mm–155 mm	556	0.558	± 0.002 ml
155 mm– 95 mm	563	0.565	± 0.014 ml
95 mm– 35 mm	560	0.562	± 0.007 ml
Mean		0.560	± 0.01 ml

* Four replicates determined for each section.

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[1] Published with permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the authors.

all joints leakproof. If uniform bore tubing is not used, then selected sections of the manometer should be used for delivery. The apparatus is calibrated by weighing portions of water delivered by the pipette. Table 1 shows the reproducibility of the volumes delivered, using various sections of a manometer made from random laboratory glass tubing. The accuracy of the delivered volumes compares favorably with that obtained by hand pipetting from calibrated pipettes.

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NEWS and Notes

E. N. da C. Andrade, Quain Professor of Physics at the University of London, will become director of the Royal Institution of Great Britain and resident professor and director of the Davy Faraday Research Laboratory on January 1. Dr. Andrade succeeds **E. K. Rideal,** who has been head of the Royal Institution since 1946.

Ju Chin Chu, director of research in the Department of Chemical Engineering at Washington University, St. Louis, has been appointed associate professor of chemical engineering at Polytechnic Institute of Brooklyn.

Raymond B. Montgomery, of Woods Hole Oceanographic Institute, has been appointed professor of oceanography at Brown University, Providence, Rhode Island. This is the university's first course of instruction in oceanography.

P. B. Medawar, professor of zoology at the University of Birmingham, England, has been appointed John M. Prather Lecturer in Biology at Harvard University this fall. During the first three weeks of November, Dr. Medawar will give a series of six lectures on "Growth, Individuality, and Ageing."

Charles M. Slack has been made technical director of the Westinghouse Electric Corporation's Atomic Power Division, which is now working on an atomic power plant for naval ship propulsion in cooperation with the Argonne National Laboratory of Chicago.

Howard A. Jones has been named assistant director of laboratories for U. S. Industrial Chemicals, Inc., New York City. He will be located at the research and development laboratories in Baltimore.

Victor A. Greulach, botanist in the Department of Plant Physiology, Agricultural and Mechanical College of Texas, has been appointed associate professor of botany at the University of North Carolina, Chapel Hill.

H. Lowell Olson, former University of Wisconsin physicist, has joined the staff of the Applied Physics Laboratory of Johns Hopkins University at Silver Spring, Maryland.

Visitors to U. S.

Christopher Howard Andrewes, head of the Department of Bacteriology and Virus Research, National Institute for Medical Research, Hampstead, London, will lecture at the Harvard Medical School, November 3, 8, and 10. The lectures, to be presented under the Edward K. Dunham Lectureship for the Promotion of the Medical Sciences, will deal with the subject of viruses.

Carl F. von Weizsäcker, professor of physics at the University of Göttingen and at the Max Planck Institute, has arrived here to spend the fall and winter quarters as Alexander White Visiting Professor at the University of Chicago. Dr. von Weizsäcker will present a series of public lectures on "The Modern Concept of Nature" and teach on the staff of the university's Committee on Social Thought.

Margaret Hardy, of Strangeways Laboratory, Cambridge, England, will be a guest research worker in the Tissue Culture Laboratory of the University of Texas Medical Branch, Galveston, in January, 1950. Dr. Hardy plans also to visit the Dermatology Laboratories of Harvard Medical School at the Massachusetts General Hospital, Boston.

Attilio Rampoldi, Italian surgeon and specialist in physical medicine at the University of Rome Clinic, has begun five months' study at the Columbia University College of Physicians and Surgeons. Brought here through efforts initiated by the Foster Parents Plan for War Children, Dr. Rampoldi will study the most recent techniques for treating disabled children. The university contributed a scholarship and the Columbian Civic Club of Newark provided $3,000 toward Dr. Rampoldi's traveling and living expenses.

Gerhart Kessler, visiting instructor from Stuttgart Institute of Technology, Germany, is studying procedures of engineering education at Illinois Institute of Technology this month. Dr. Kessler is also engaged in electrotechnical research at Stuttgart Institute. His visit here is being sponsored by the U. S. Office of Military Government for Germany and the Federal Security Agency's Office of Education.

Grants and Awards

The Farrer Memorial Medal for 1949 has been awarded to W. L. Waterhouse, research professor of agriculture at the University of Sydney, Australia. Dr. Waterhouse received the medal in recognition of his research on wheat diseases and their control.

The Jane Coffin Childs Memorial Fund for Medical Research granted to Gray H. Twombly, Department of Cancer Research, College of Physicians and Surgeons, Columbia University, $5,000 for studies on the selective localization of radioactive estrogens and allied substances in normal and cancer-bearing tissues. It was erroneously stated in the August 19 issue of *Science* that this grant had been made to Frances L. Haven, Biochemistry Department, University of Rochester School of Medicine and Dentistry. Dr. Haven's grant of $3,000 was for studies on the storage and mobilization of fat in tumor-bearing rats.

The Dazian Foundation of New York has awarded a research fellowship to Albert S. Gordon, associate professor of biology at New York University. Dr. Dazian will conduct research on mechanisms underlying the effects of endocrine factors in hemopoiesis.

Theodore Koppanyi, professor of pharmacology and materia medica, Georgetown University School of Medicine, has been elected an honorary member of the Society of Pharmacology and Therapeutics of the Argentine Medical Association.

Fellowships

The Medical Fellowship Board of the National Research Council is now accepting applications for postdoctoral research fellowships for 1950–51 under the following programs:

National Research Fellowships in the Medical Sciences, supported by grants from the Rockefeller Foundation, provide opportunities for experience in research in all branches of medical science. They are open to citizens of the U. S. or Canada who hold the M.D. or Ph.D. degree. As a rule, candidates should be under 30 years of age.

Welch Fellowships in Internal Medicine, also supported by the Rockefeller Foundation, provide a prolonged period of advanced training to persons of proven research ability. They are open to physicians under 40 years of age who are citizens of the U. S.

Fellowships in Poliomyelitis and related fields are supported by the National Foundation for Infantile Paralysis, Inc. They provide training and experience in the study of virus diseases, and in any field contributing to progress in orthopedic surgery. Candidates for fellowships in virus diseases must hold the M.D. or the Ph.D. degree. Fellowships in orthopedic surgery are open only to graduates in medicine who have completed one or more years of hospital work in clincal surgery. Applicants must be citizens of the U. S. and, as a rule, should be under 30 years of age.

Senior Fellowships in Poliomyelitis and related fields are also available under grants from the National Foundation for Infantile Paralysis, Inc. They provide, for persons of proved research ability, opportunity for advanced training and research in the fields of clinical neurology, epidemiology, orthopedic surgery, pediatrics, and virus diseases. Applicants must be U. S. citizens under 40 years of age. Senior fellowships in the field of virus diseases are open to physicians and to holders of the doctorate in the basic sciences; applicants in the four other fields must be graduates in medicine.

Fellowships in Anesthesiology have been made available by a grant from the American Society of Anesthesiologists, Inc. They are designed to relate the disciplines of anatomy, biochemistry, pharmacology, physics, and physiology to problems of clinical anesthesia. Applicants must have the M.S. degree and at least one year of hospital experience.

Follows will be appointed at a meeting of the Medical Fellowships Board early in March, 1950. Applications for consideration at this meeting must be filed before *December 1.* Appointment may begin at any date determined by the board. For further information address the Secretary of the Medical Fellowship Board, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C.

The Solvay Process Division of Allied Chemical and Dye Corporation has established two graduate fellowships for research on additives to concrete at the Engineering Experiment Station of the University of Kentucky, Lexington. The studies will be directed principally toward increasing the workability of concrete through chemical additives.

Meetings and Elections

A symposium on Tropospheric Wave Propagation, sponsored by the U. S. Navy Electronics Laboratory at San Diego, was held at the NEL laboratory on Point Loma during the week of July 25–29. Organized by Charles R. Burrows, director of the School of Electrical Engineering at Cornell University, Ithaca, New York, the symposium attracted between 50 and 60 specialists in this branch of science, from the U. S., Alaska, and Europe.

Following addresses of welcome by Rawson Bennett, director of NEL, and J. P. Maxfield, chief scientist, representatives of various government facilities conducting radio wave propagation experiments gave talks on the work in progress at their various establishments.

The scientific papers which followed were divided into two main groups—those having to do with atmospheric refraction and those having to do with scattering. An additional session was devoted to hydrometeors and atmospheric absorption. A final session consisted of a lively discussion on topics suggested by participants of the symposium during the earlier sessions.

It was generally agreed that the size of the group was ideal for the informal personal participation which contributes so much to the development of science. An informal dinner at the Admiral Kidd Commissioned Officers Mess, and an all-day inspection trip to the Palomar Astronomical Observatory added to the enjoyment of the participants and contributed to the free discussion of the subject matter of the conference among the visiting scientists.

During sessions on refraction, the data obtained by the NEL on propagation over water in the San Diego area and in propagation over the desert in Arizona were presented and discussed at length, together with the data obtained by the Electrical Engineering Research Laboratory of the University of Texas on the angle of arrival of microwaves, both in the Arizona desert and along the Gulf of Mexico. These and other data were interpreted theoretically on the basis of the relation of the vertical gradient of the index of refraction to the laws of radio wave propagation. Methods and difficulties of obtaining the meteorological data from the radio data were also presented.

After the presentation of data on the fluctuations and scattering of radio waves in the atmosphere, collected by members of the Naval Research Laboratory and the NEL, Henry G. Booker and William E. Gordon, of the School of Electrical Engineering at Cornell University, presented their theory of atmospheric scattering. This new theory may explain the deviations of long distance tropospheric propagation from that expected on existing theories. While it is still in the formative stage, many of the consequences of the theory were discussed, and experiments for testing it were described.

C. R. BURROWS

The Theory and Organization of Complicated Automata will be the subject of a series of lectures to be presented December 12–16 at the University of Illinois by John von Neumann, of the Institute for Advanced Study. The program follows the series presented at the university last year by Douglas R. Hartree, British physicist.

The American Meteorological Society will hold its 30th anniversary meeting in St. Louis, January 3–6. The first two days will be devoted to a symposium on air pollution, under the chairmanship of C. A. Gosline, of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, sponsored by the Analytical Division of the American Chemical Society's Pittsburgh Section and the Spectrographic Society of Pittsburgh, will be held at the William Penn Hotel, Pittsburgh, February 15–17, 1950. Papers on all phases of analytical chemistry and applied spectroscopy are invited and abstracts in triplicate must be received by *November 1.*

Deaths

Knight Dunlap, 73, professor emeritus of psychology at the University of California at Los Angeles, died August 14 of pneumonia. Dr. Dunlap was for many years professor of psychology at Johns Hopkins University and was chairman of the Division of Anthropology and Psychology of the National Research Council from 1927 to 1929.

Earnest Stanley Shepherd, 70, retired research chemist at the Geophysical Laboratory of the Carnegie Institution of Washington, D. C., died in Washington on September 29. Dr. Shepherd conducted research in the application of physical chemistry to rock magmas and the measurement of the temperature of molten lava.

Sigmund Samuel Greenbaum, 59, professor of dermatology and syphilology at the University of Pennsylvania, died October 3 at his home in Philadelphia. At the time of his death, Dr. Greenbaum was also attending dermatologist at Mount Sinai and Philadelphia General Hospitals.

Leonor Michaelis, 74, physical chemist and retired member of the Rockefeller Institute for Medical Research, died October 9 of a heart attack. His most recent work was the discovery of the radical of vitamin E, the antisterility factor. A native of Berlin, Dr. Michaelis was at one time professor of biochemistry at the Medical School of Nagoya, Japan, and later resident lecturer at Johns Hopkins University.

National Health Program, 1949, a transcript of public hearings conducted last May and June by the Senate Labor and Public Welfare Committee, has been published and copies are obtainable from the committee, U. S. Capitol, Washington 25, D. C. The two-volume, 1,247-page transcript contains the testimony of American Medical Association officers, medical deans, economists, labor spokesmen, and others on compulsory health insurance, voluntary prepayment plans, federal support of medical and dental education, hospital expansion, and other national health issues.

Central Scientific Company announces the opening of a new office at 347 Madison Avenue in New York City to facilitate service in that area on scientific instruments, laboratory supplies, and chemical reagents from unlimited stocks.

At a meeting held at the University of Brussels, Belgium, March 28–30, electrochemists from several Western European countries created a new international organization designated as the **Committee of Electrochemical Thermodynamics and Kinetics.** The goal of the committee is to facilitate and promote international collaboration in these fields. In each country where collaboration is secured, there will be a delegate in charge of coordinating the various activities within the program of the committee.

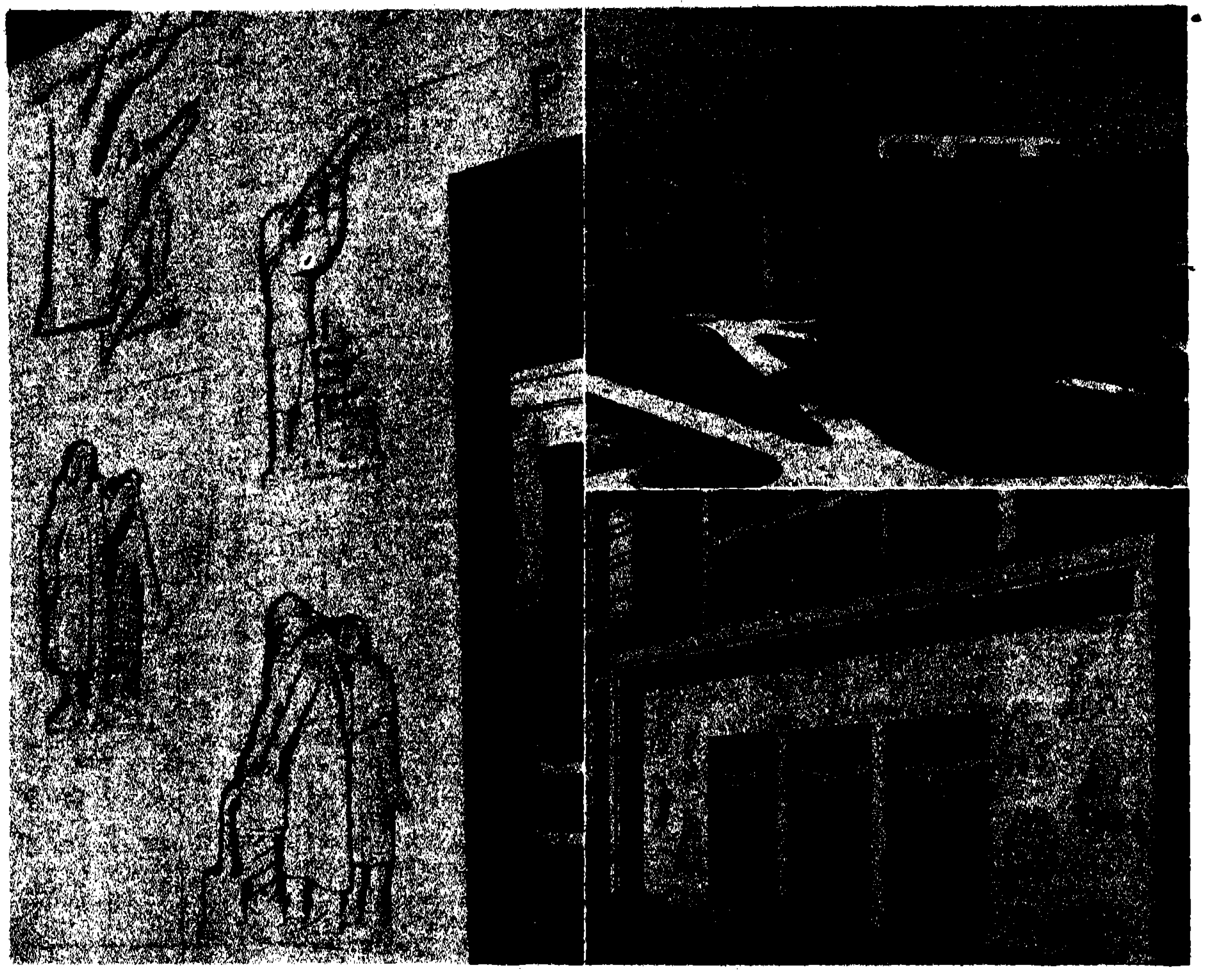
The officers of the committee are: Pierre Van Rysselberghe, University of Oregon, president; M. Pourbaix, University of Brussels, secretary. Delegates have been selected as follows: A. Juliard, Brussels, for Belgium; F. E. W. Wetmore, Toronto, for Canada; J. Heyrovsky, Prague, for Czechoslovakia; G. Charlot, Paris, for France; T. P. Hoar, Cambridge, for Great Britain; R. Piontelli, Milan, for Italy; W. G. Burgers, Delft, for the Netherlands; A. B. Winterbottom, Trondheim, for Norway; E. Jimeno, Madrid, for Spain; and E. Wyler, Bern, for Switzerland.

Research planned at the meeting includes: 1. Preparation of an "Atlas of Electrochemical Equilibria," which will be an extension of the fundamental work of Dr. Pourbaix on the potential-pH diagrams of iron, copper, chromium, etc., to all elements for which the necessary data are available. This atlas is being prepared by Drs. Pourbaix, Delahay, and Van Rysselberghe. 2. Systematic determination of polarization curves for electrochemical reactions. This program would consist of the extension of the fundamental work of Drs. Wagner and Traud, of the development of the polarographic method, and of overvoltage studies, etc. 3. Applications of the two foregoing groups of studies to corrosion, catalysis in solutions, electrolytic phenomena, analytical chemistry, etc.

Inquiries may be addressed to P. Van Rysselberghe, Department of Chemistry, University of Oregon, Eugene, Oregon.

Status of AAAS Meeting Reservations

The early and heavy demand for *single* rooms already indicates a potential shortage of this type of accommodations at the **116th Meeting of the AAAS in New York City,** December 26–31. There are plenty of hotel rooms but many have double or twin beds. Miss Sylvia T. Peltonen, Manager, Housing Bureau, New York Convention and Visitors Bureau, 500 Park Avenue, New York 22, who is in charge of room assignments, urges that, when possible, room reservations be placed by parties of two or more. This also has the advantage of a lower cost per person. Room reservation coupons will appear in the advertising pages of *Science* at frequent intervals.



A unique feature of the new $1,700,000 **Michigan State College Mathematics and Physics Building** is the stone carving on the main and side entrance panels, which tells the history of mathematics and physics. Designed by Carl L. Schmitz, New York sculptor, the work is done in sunken relief, a method widely used by the ancient Egyptians, and comparatively rare today.

Panels at the left of the main entrance depict Newton under a tree, watching an apple fall, Galileo with a pendulum in his hand, Archimedes immersing King Hieron's gold crown in water, and Huygens holding a telescope.

At the right of the entrance Franklin is shown flying his kite, Faraday contemplating a cell through which an electric current is being passed, Newton and Leibnitz discussing a problem by the methods of calculus, and Oersted demonstrating the magnetic effect produced by an electric current.

Above the main entrance are various forms of simple machines—from left to right, the lever, the pulley, gears, the screw, and the inclined plane.

The building houses 135 classrooms and laboratories, one laboratory being two stories high, for experiments using very tall equipment. A central control panel permits any desired voltage and frequency of current to be piped to any laboratory. Equipment to be installed includes an electron microscope, x-ray apparatus for analysis of atomic properties, various radio and radar instruments, and a 10-inch telescope on the building's flat roof.

Thomas H. Osgood is director of MSC's Division of Mathematics and Physical Sciences.

Make Plans for—

Industrial Minerals Division of the American Institute of Mining and Metallurgical Engineers, November 9–12, Tampa Terrace Hotel, Tampa, Florida.

National Symposium on Air Pollution, sponsored the Stanford Research Institute, the California Institute of Technology, and the Universities of California and Southern California, November 10–11, Huntington Hotel, Pasadena, California.

International Symposium on High Altitude Biology, November 23–30, Lima, Peru.

Pittsburgh Conference on X-Ray and Electron Diffraction, November 7–8, Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania.

The National Academy of Sciences

Abstracts of Papers Presented at the 1949 Autumn Meeting, Rochester, New York

Reflection and Transmission Type Interference Filters

A. F. Turner, ***Bausch & Lomb Optical Company***
(Introduced by F. E. Wright)

Thin films may be combined to produce narrow band pass filters, which owe their effectiveness to interference. By means of high vacuum techniques, such film combinations have been satisfactorily produced up to a diameter of 8 in., and larger sizes are feasible. A filter for transmission is made by depositing successively a film of silver, a spacer film of a dielectric, and a second silver film. The thickness of the spacer film controls the wavelength position of the pass band. The optical properties of the silver limit the use of this filter to a wavelength range of about 350–750 $m\mu$. The best optical performance is obtained in the middle of this range, where a filter with 40% transmittance will have a half-width of 10 $m\mu$. The wavelength range may be greatly extended with a reflection type filter in which the film sequence is opaque aluminum, followed by several transparent aluminum films separated by dielectric films. Such filters are operative from the ultraviolet into the infrared, but have relatively wide pass bands. In the visible a typical filter has a peak reflectance of 90%, with a half-width of 60 $m\mu$. Both types of filter will be demonstrated.

Diffraction Gratings of Improved Efficiency

David Richardson, ***Bausch & Lomb Optical Company***
(Introduced by F. E. Wright)

The efficiency of a grating is determined principally by the contours of the grooves and the reflectivity of its surface. The shape, orientation, and loading of the ruling diamond must be carefully controlled if the desired groove shape is to be achieved. The microinterferometer has proved to be invaluable for observing the groove shape of preliminary test rulings and thus assuring the correct adjustment of the diamond. Energy distribution measurements of completed gratings indicate the value of the method.

Invariants and Symmetry and Their Use in Geometric Optical Problems

Max Herzberger, ***Eastman Kodak Company***
(Introduced by W. Albert Noyes, Jr.)

An optical system is in general symmetric around an axis. A special type of optical system is one with central symmetry, consisting of a series of spheres with the same center. The author has developed, together with his friend, H. Boegehold, a theory which gives complete information about their image formation. This leads to a new image error theory, in which symmetry or the lack of it is used as a method for analyzing an optical image.

In a system with point symmetry, there exists an invariant vector for every ray trace. In a system with areal symmetry, there exists an invariant scalar. The author has transformed the formula for tracing a ray or a bundle of rays through an optical system into a form in which the invariant scalar or vector forms one of the given data. This permits ray tracing to be reduced by one dimension—an important reduction, since the graphical methods connected with this step are a guide in the difficult problem of correcting an optical instrument.

Developments in the Field of Ultraviolet Microscopy

John V. Butterfield, ***Bausch & Lomb Optical Company***
(Introduced by F. E. Wright)

The original conception of the ultraviolet microscope was evolved from a desire to extend the resolution limit of the microscope beyond the limit imposed by visual wavelengths. Of equal, and at present perhaps even greater importance, are its applications in biochemistry for direct photographic recording of biological tissue or for microphotometric determinations of biochemicals. With the advent of achromatic objectives applicable to the ultraviolet, the manipulation of the microscope in this region has been simplified, and the usefulness of the instrument extended considerably.

Fluctuations in the Photoconductivity of Films of Lead Sulfide

Brian O'Brien, Harry D. Polster, and Walter P. Siegmund
Institute of Optics, University of Rochester
(Introduced by W. A. Noyes, Jr.)

The concept that photoconductivity in thin films of heavy metal sulfides is due to photosensitive barriers between regions of excess and defect conductivity has received considerable support from several recent investigations in which a film surface has been scanned with a small spot of light. To extend this, provision has been made for exploring such surfaces with much smaller light spots, limited in minimum size only by the diffraction pattern of a high numerical aperture objective. An interrupted tungsten filament source is projected on the film with an apochromatic system corrected for the near infrared, and yielding an image of effective width about 1.5 μ. The photoconductivity appears as an alternating voltage recorded by a curve-drawing instrument synchronized with the film scan.

Films of lead sulfide formed by distillation and by wet precipitation have been investigated. The photoconductivity shows large and rapid fluctuations with position of the illuminated spot, which are highly reproducible in successive traces. Photoconductivity may change by a factor of two or more in a distance of 10 μ. However, the most common pattern observed consists of sharp drops below, rather than sharp peaks above, a general level of photoconductivity, which is difficult to reconcile with a barrier theory.

Correlations between Photographic and Photoconductive Sensitivity in Silver Halides: The Effects of Silver Sulfide and of Divalent Positive Ions

W. West and B. H. Carroll, *Eastman Kodak Company*
(Introduced by W. Albert Noyes, Jr.)

The electrical conductivity of photographic films changes slightly on exposure to light, the effect being measurable in some cases at exposures corresponding to normal latent image formation. The usual effect is an increase in conductivity, corresponding to liberation of electrons by light. It has been found that chemical sensitization of emulsions by compounds forming silver sulfide decreases the photoconductivity. The decrease is about 50%, which is a reasonable value for the trapping of electrons by the sensitivity nuclei. The evidence indicates that emulsion grains contain many shallow traps for electrons, to which chemical sensitization adds a few deep traps.

Silver bromide containing small amounts of lead or cadmium bromide has increased electrolytic conductivity and darkens very slowly on exposure to light. It has been found that fused, unannealed films containing these divalent cations show normal photoconductivity, although corresponding films of pure silver bromide decrease in conductivity on exposure. This result may be explained best in terms of Mitchell's theories of sensitivity, based on the existence of Schottky defects.

The Theory of Micrometeorites

Fred L. Whipple, *Harvard College Observatory*
(Introduced by L. H. Adams)

The term *micrometeorite* is here defined as an extraterrestrial body that is sufficiently small to enter the earth's atmosphere without being damaged by encounter with the atmosphere. The limiting circumstance arises when the micrometeorite radiates energy rapidly enough that its temperature remains below its melting point as its motion is retarded by atmospheric resistance. The theory of the maximum dimension for such a particle with prescribed geocentric velocity and physical characteristics is developed in this paper. The solution depends upon the height-density relation adopted for the atmosphere. Two types of such relations permit explicit solutions for the limiting ratio of meteoric mass to radiating area, or, if the particle is spherical, for the limiting radius. These atmospheric relations are a) constant temperature, and b) constant temperature gradient, both for constant molecular weight with respect to height. The second case appears to give a sufficiently accurate results for present needs.

The limiting radius for a spherical micrometeorite varies approximately as the fourth power of the melting temperature, the inverse cube of the velocity, the inverse logarithmic density gradient at the point of maximum temperature, and the secant of zenith distance. Heights of maximum temperature increase with velocity but lie in the neighborhood of the E-layer. For an iron meteorite at a velocity of 23 km/sec, the limiting spherical radius is 3–5 μ. Long cylindrical particles may have a minor diam of 4–7 μ—in good agreement with the minor dimensions of the "wedge-shaped opaque" magnetic particles that H. E. Landsberg associated with the great Giacobinid meteor shower in October 1946 (velocity 23 km/sec). His larger "round" particles (20–40 μ diam) may have been partially vaporized. This general agreement provides secondary confirmation of the assumed atmospheric relations at the 100-km level.

The writer heartily encourages the collection and study of micrometeorites, as they may provide the only laboratory samples of cometary material; ordinary meteorites probably arise from a different source. Deep oceanic sediments, as suggested by the *Challenger Expedition*, polar snows, or even *geological strata may also contain* evidence of astronomical phenomena.

Chemical Constitution and Photographic and Allergenic Activities of Color-forming Developing Agents

A. Weissberger, *Eastman Kodak Company*
(Introduced by W. A. Noyes, Jr., Chairman, Local Committee on Arrangements)

The only developing agents useful for processes involving formation of dyes in the photographic layer are *p*-aminodialkylanilines. These compounds are, as a class, rather weak developing agents. Moreover, they cause a sensitization dermatitis like poison ivy.

A considerable number of compounds were synthesized and their polarographic half-wave potentials and developing and color-forming activities were measured. The results lead to an understanding of the electrochemical and sterical factors which regulate the activity of these developing agents. Groups which increase the affinity of the compounds to gelatin (keratin) and decrease their lipoid solubility reduce their allergenic properties. A number of photographically highly active, low allergenic, dye-forming developing agents have been synthesized.

On the Possible Existence of Antinucleons

J. Ashkin, T. Auerbach, and R. Marshak
University of Rochester
(Introduced by W. A. Noyes, Jr.)

Recent evidence for the gamma instability of neutral mesons and the possibility of detecting relativistic charged mesons in the new electron-sensitive plates renews interest in the possible existence of antinucleons, in particular negative protons. Rigorous expressions have been obtained for the annihilation cross sections of proton pairs using weak coupling theory and spin zero mesons. The annihilation cross section vanishes in the limit of zero velocity for the emission of two neutral mesons but reaches a maximum for the emission of two charged mesons. The charged meson annihilation therefore dominates over the proton annihilation. The total probability for annihilation of the negative proton in flight has been computed, taking account of its ionization loss and the effect of nuclear collisions. The prospects of detecting negative protons annihilating in flight or at rest in photographic plates exposed at 100,000 ft appear hopeful.

Proton-Proton Scattering

C. L. Oxley, Physics Department, *University of Rochester*
(Introduced by W. A. Noyes, Jr.)

This paper is to review the proton-proton scattering program at Rochester, to present future plans of the program, and to connect the program with the problems of the field and with work in other laboratories.

General features of the Rochester program are photographic plate experiments with the small cyclotron at energies of 7 Mev and less, counter experiments with the undeflected beam of the new synchrocyclotron at energies from 250 Mev to 50 or 100 Mev, and a search for inelastic proton-proton scattering as might occur with the excitation of isobaric proton states.

The program was initiated by and has progressed with the guidance of S. W. Barnes. Support is derived from grants of the Research Corporation and the joint program of the Office of Naval Research and the Atomic Energy Commission.

Prediction of Compressibility of Real Gases and Gaseous Mixtures from Critical Pressure and Temperature

Gouq-Jen Su, Ramesh G. Soparkar and Robert J. Lockhart
Department of Chemical Engineering,
The University of Rochester
(Introduced by W. A. Noyes, Jr.)

Based on a modified "law" of corresponding states, a system of generalized isometrics is presented, covering experimental data on seventeen gases over wide ranges of pressure and temperature and seeming to be applicable to all gases. A ternary gaseous mixture consisting of methane, *n*-butane and decane at five different compositions has been studied. Calculated and experimental values of compressibility factors agree well. Calculated changes of enthalpy with pressure, making use of a generalized form of the Beattie-Bridgeman equation of state, for the methane-ethane system agree well with experimental values reported in literature. The same method may be used to calculate isothermal changes of other thermodynamic functions.

The proposed method of correlating pressure-volume-temperature data by the generalised relationship has the advantage of not requiring knowledge of the critical volume.

The Heavy Nuclei of the Primary Cosmic Radiation

H. L. Bradt and B. Peters, *University of Rochester*
(Introduced by W. A. Noyes, Jr.)

The abundance of atomic nuclei of the light elements in the primary cosmic radiation has been determined at geomagnetic latitudes $\lambda = 30°$, $51°$, and $55°$ with the aid of photographic emulsions exposed in balloon flights at 100,000-ft altitude.

The abundance ratios may be compared with the abundance of the atoms of the light elements in stellar atmospheres and interstellar space.

The most abundant nuclei in the primary cosmic radiation are H nuclei (relative intensity = 10,000). Next come He nuclei (1000), nuclei of C, N, O, and possibly F or Ne (60), nuclei of Mg, Si and neighboring elements (10) and nuclei of charge $Z > 15$ up to the neighborhood of Fe (10).

The abundance of nuclei in the primary cosmic radiation may be determined by several factors, among them: (a) the abundance of atoms (or ions) in the region where acceleration took place; (b) the dependence on charge and mass of the efficiency of the acceleration process; and (c) the breakup of heavier nuclei into lighter ones by collision with interstellar H atoms. This latter factor will be important if cosmic rays are of galactic origin.

The relative importance of factors (a) and (c) may be obtained from a determination of the abundance of primary nuclei whose cosmic abundance is known to be extremely low (Li, Be, and B).

The Pre-exponential Factor for Some Reactions of Methyl Radicals

Leon M. Dorfman and Robert Gomer
Department of Chemistry, The University of Rochester
(Introduced by W. A. Noyes, Jr.)

Recent kinetic data on the role of methyl radical reactions in the photochemistry of various compounds permit the evaluation of relationships between the pre-exponential factor for the association reaction

$$CH_3 + CH_3 = C_2H_6$$

and that for hydrogen abstraction reactions of the type

$$CH_3 + RH = CH_4 + R$$

Evaluation of the relative steric factors is possible upon the assumption of arbitrary collision cross sections for these reactions. For the reaction of methyl radicals with acetone, dimethyl mercury, ethylene oxide, butane, and ditertiary butyl peroxide, the data indicate that the steric factors for the methane-forming reactions are lower than has normally been assumed. On the basis of these data an upper limit of $p \simeq 5 \times 10^{-4}$ must be assigned.

γ-Aminobutyric Acid: A Constituent of the Potato Tuber?

F. C. Steward, J. F. Thompson,[1] and C. E. Dent[2]
University of Rochester
(Introduced by W. Albert Noyes, Jr.)

The first examination by Dent, Stepka, and Steward of the free amino acids of the potato tuber by partition chromatography on paper revealed 27 different substances which react with ninhydrin. Of these substances 21 were either amino acids or amides or their derivatives which, though they may not have been previously demonstrated in a single plant extract, were nevertheless known to occur in plants. Three unidentified substances reacted like amino acids to ninhydrin. Of these, two occurred only in small amount, one was tentatively recognized as β-alanine, but the third was present in relatively large amount. It is this substance, which—after glutamine and asparagine—is the most abundant soluble nitrogen compound in the potato tuber, that is now recognized as γ-aminobutyric acid.

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[1] Postdoctoral Fellow, National Institutes of Health.

[2] Present address: University College Hospital, London, England.

γ-Aminobutyric acid occurs in the phenol: collidine-lutidine chromatograms in a position almost immediately below that of valine. The naturally occurring product may be isolated by the methods of paper chromatography and freed from all other known ninhydrin-reacting compounds. It is stable to hydrolysis and to hydrogen peroxide and is chromatographically identical with synthetic γ-aminobutyric acid (prepared from the lactin). Since, however, this acid has not hitherto been recognized as a normal constituent of plants, some confirmation by an alternative method is desirable.

As isolated by paper chromatography from cold alcoholic extracts of potato tuber, the γ-aminobutyric acid is difficult to crystallize—more so than the synthetic product when present in comparable amount. This appears to be due to a substance which does not react with ninhydrin but which causes the formation of a noncrystalline glass. This has made it difficult to obtain satisfactory x-ray diffraction patterns to compare with those of crystalline synthetic γ-aminobutyric acid.

One of us (C. E. Dent) has, however, shown that γ-aminobutyric acid forms a compound on boiling with urea in presence of copper salts. This compound can be adsorbed on acid alumina. The ureide takes up a characteristic position on the standard phenol: collidine-lutidine chromatograms near to that of methionine sulfone, where it may be detected by a yellow color formed with acid *p*-dimethyl-aminobenzaldehyde. In this behavior the natural product from potato tuber exactly matches the synthetic substance. However, pure γ-aminobutyric acid or its ureide have not yet been isolated in sufficient quantity for ultimate analysis. The identity of this substance as a normal constituent of the potato tuber seems, however, to be certain.

The analysis, by quantitative paper chromatography, of the alcohol-soluble nitrogen compounds of the potato tuber (variety Katahdin) shows that the amount of γ-aminobutyric acid present is greater than that of any amino nitrogen compound other than glutamine and asparagine. The content of the major constituents is here recorded in the approximate sequence in which they occur on the chromatograms, and in the units μg/g fresh weight, as follows: aspartic acid, 161; glutamic acid, 121; serine, 108; asparagine, 2300; threonine, 52; alanine, 189; glutamine, 2493; γ-aminobutyric acid, 540; valine, 358; leucine, 478. Thus γ-aminobutyric acid accounted for about 5% of the alcohol-soluble and for 3.7% of the total nitrogen in these tubers.

Glutamic acid decarboxylase activity in the tubers was demonstrated manometrically but the activity was small; so that it is even open to question whether the γ-aminobutyric acid does arise by decarboxylation of glutamic acid (α-aminobutyric acid, the other possible decarboxylation product, occurs in potato only in minute amounts). In view of the importance of glutamic acid and glutamine in nitrogen metabolism, the role of γ-aminobutyric acid and its relation with these substances is of great interest.

γ-Aminobutyric acid does not occur among the hydrolytic products of potato proteins; it is, however, utilized as a nitrogen source if the potato cells are brought under conditions conducive to protein synthesis.

From the evidence of chromatography, free γ-aminobutyric acid seems to be somewhat widespread in plants.

Electric Moments of Polar Polymers in Relation to Their Structure

Peter Debye and F. Bueche, *Cornell University*

From the observed angular dissymmetry of the light scattered by polymer solutions it has been possible to draw conclusions on the average size of the polymer coil. In general, the actual coil diameter found in this way is much larger than that calculated from a model with free rotation. (For polystyrene in benzene the factor is about 3.5). This increase in size can satisfactorily be attributed to hindering of rotation around the chemical bonds. In order to obtain information about structural details of this hindered rotation, however, the size determination will have to be combined with evidence derived from other sources than light scattering. As such, the dipole moment, as derived from measurements of the dielectric constant of polymer solutions, obviously is a good choice. If *N* polar monomers are influenced independently by the electric field, their contribution to the polarization will be *N* times the contribution of a single monomer. If they are connected to each other in the chain, the contribution of the whole chain may be larger or smaller, depending on whether positions of parallelism or antiparallelism of the elementary electric moments are preponderant, taking the average over all the possible forms the coiling molecule can assume. A theory of this effect has been worked out and experiments have been carried out on solutions of several polar polymers. One of the examples is *p*-chloropolystyrene, for which the average contribution to the polarization of one chain element is substantially smaller in the polymer than that of the corresponding monomer.

Adsorption Isotherms and Liquid Solutions

George Scatchard, *Massachusetts Institute of Technology*

It has long been known that Langmuir's equation for monolayer adsorption is identical in form to the equilibrium expression for chemical reaction between quasi-perfect gases or quasi-ideal solutes. The Brunauer-Emmett-Teller equation for multilayer adsorption may be shown by factoring to have the same form as the equilibrium expression for a chemical reaction between the solvent and solute in a quasi-ideal solution in which each mole of solute, on the average, can react with one mole of solvent.

Factoring offers a simple and reasonable, but not very useful, method of adding a third parameter to the BET equation. Its chief use for surfaces is to enable a large scale picture even at high activities.

For liquid solutions the method gives a measure of the deviations from ideal solution laws, analogous to the activity coefficient or osmotic coefficient, which is especially adapted to the study of combination in quasi-ideal solutions without association. Association and electrostatic interaction are relatively unimportant in concentrated solutions.

For salt solutions in water, the hydration is much greater than mole per mole. The most important extensions are for different intrinsic constants for hydration of anion and of cation and for constants changing with the number of groups added, and next come the variations in activity coefficients with changing composition.

The Saturation Equation in Chemical Kinetics

W. H. Rodebush, ***University of Illinois***

One can easily demonstrate that the typical adsorption isotherm, expressed mathematically in various forms, is only a special case of a much more general type of phenomenon which appears wherever molecular interactions occur. Olsen has applied the idea to the activity of strong electrolytes. The same idea turns up repeatedly in homogeneous catalyzed chemical reactions where a catalyst or inhibitor at first shows effects proportional to concentration and then gives diminishing returns. In the absence of a better term, the phenomenon may be described as saturation and so represented by a typical curve. Since "pure" uncatalyzed reactions are of academic interest chiefly, it is felt that this idea may be of considerable practical significance.

Factors Determining Solubility among Nonelectrolytes

Joel H. Hildebrand, ***University of California***

The variety of factors that must be considered in interpreting solubility relations among nonelectrolytes will be illustrated by the solubilities and colors of iodine in solvents of various types. New, unpublished data obtained for this purpose will be considered, along with the extensive body of information available from previous work. The theory of regular solutions, with its formulations of the energy and entropy of mixing, will be applied to the violet, "regular" solutions, which represent over a thousandfold range in solubility, and the deviations therefrom which may result from dipole moments, hydrogen bonding, molecular shapes and sizes, or acid-base interaction will be discussed.

Cyanic Acid and the Allophanates

John R. Johnson and Louis L. Ferstandig
Cornell University

Studies have been made of the mechanism of the reaction of cyanic acid with alcohols to form esters of allophanic acid, R—O—CONHCONH$_2$. The evidence indicates that neither "dicyanic acid" nor the alkyl carbamate is an intermediate under the usual conditions for transforming alcohols into allophanates.

The mechanism of hydrolysis of allophanates in neutral, acidic, and basic media has been investigated. Allophanates of tertiary and allylic alcohols undergo hydrolysis rapidly in neutral aqueous medium at 100° by a process involving cleavage of the alkyl-oxygen bond. Under alkaline hydrolytic conditions the alkyl-oxygen bond remains intact.

The allophanates are crystalline compounds particularly suited for characterization of tertiary alcohols.

Studies in Diagnostic Cinefluorography: Familiar Radiographic Views as Seen in Slow Motion

G. H. S. Ramsey, J. S. Watson, Jr., J. J. Thompson, F. Dreisinger, R. T. Weinberg, and S. Weinberg
University of Rochester
(Introduced by Wallace O. Fenn)

Equipment designed and built in the Department of Radiology, University of Rochester, has been used to produce a cinematographic record of the shadows produced by x-rays on the fluorescent screen. A number of scenes have been incorporated in a film that will be shown. This film will serve to demonstrate the range of usefulness of this method of study in teaching, diagnosis, and research.

Production and Utilization of Plasma Proteins Studied with Radioactive Lysine

Leon L. Miller, ***University of Rochester***
(Introduced by George H. Whipple)

DL-Lysine labeled with C^{14} in the epsilon position has been fed to normal dogs and the relative apparent rates of incorporation of the labeled amino acid in the various plasma protein fractions have been studied. The data indicate that the plasma globulin fraction is synthesized more rapidly than the plasma albumin. This conclusion is substantiated by experiments in which plasma proteins labeled with C^{14} were transfused into a normal recipient dog. Here the labeled globulin fraction disappears from the circulation faster than the labeled albumin fraction. These experiments permit estimates of the half-life of the plasma albumin and globulin fractions.

In vitro studies of surviving rat livers perfused with whole blood containing added DL-lysine-ε-C^{14} have yielded direct evidence of the hitherto presumed role of the liver in the production of plasma proteins.

Hemoglobin Synthesis and Turnover in Dogs Measured with Radioactive Lysine

Charles L. Yuile, ***University of Rochester***
(Introduced by George H. Whipple)

Following the feeding of racemic lysine labeled with C^{14} to an essentially normal dog, about 70% of the total incorporation that occurred in hemoglobin in a 12-day period took place in the first three days. In an anemic and hypoproteinemic dog 80% of the maximum incorporation occurring over a period of 22 days took place in the first five days. These data suggest that the period of bone marrow maturation of the red cell during which its related hemoglobin is synthesized does not exceed three to five days. Evidence based on the rate of decrease of the C^{14} content of circulating blood cells over a prolonged period indicates an average life span of 115 days for the erythrocytic protein, which corresponds closely to estimates of the life span of dog erythrocytes by other methods. Following breakdown of blood erythrocytes, the protein comprising them is not used preferentially for the formation of new erythrocytes.

Solubilization and Separation of Components of the Heart Muscle Oxidase System

Elmer Stotz, ***University of Rochester***
(Introduced by *Wallace O. Fenn*)

Cytochrome oxidase, cytochromes A, B, and C, and succinic dehydrogenase have long been recognized as having prime importance in the oxidative capacity of animal, bacterial, and probably of many plant cells. Heart muscle, because of its high content of these substances, has been a favorite tissue for study. Ground heart muscle can be extensively washed with water without removing these substances, although a weakly alkaline extraction with grinding yields a preparation of finely suspended insoluble particles containing all of the above components. Only cytochrome C, because of its exceptional stability toward acid, has been shaken loose from its combination with these particles and satisfactorily characterized. The other components remain attached, have been unsusceptible to the usual methods of protein purification, and are consequently ill-defined as chemical entities.

Following leads provided by studies of natural digestive processes, the heart muscle particle suspension has been dispersed by the addition of sodium cholate and subjected to the digestive action of several types of enzymes. After the action of some of these enzymes, the particles are so reduced in size that the cytochrome oxidase activity nearly all remains in solution upon centrifugation at 20,000 *G*. Furthermore, the digested preparation is then susceptible to a fairly sharp fractionation with ammonium sulfate. The oxidase has thus been purified several fold and is free of cytochrome C, but still contains cytochromes A and B and some succinic dehydrogenase.

Suitable modification of the above procedure has led to cytochrome A preparations with very low cytochrome oxidase activity. With the same starting material a soluble succinic dehydrogenase, highly concentrated and purified about 40 ×, has been obtained. With the various compounds brought into soluble form, the application of classical protein fractionation procedures may lead to further purification and separation of the components, whose interrelationships in oxidative metabolism may then be revealed.

The Phenomenon of Gel Formation by Isolated Cell Nuclei

Alexander L. Dounce, ***University of Rochester***
(Introduced by Wallace O. Fenn)

The formation of gels as the result of adding dilute ammonia or strong saline solutions to different types of isolated cell nuclei has been described previously. In this paper further observations are reported on gel formation by isolated nuclei, particularly those obtained by a modification of the technique of Behrens. It is shown that nuclei isolated from rat liver or rat tumor (Walker carcinoma 256) at pH 4.0, or lower, form a gel upon adding dilute ammonia or sodium hydroxide, whereas nuclei obtained from chicken erythrocytes at pH 6.8, as well as nuclei isolated from rat liver or tumor by the modified Behrens technique, yield a gel upon adding strong saline as well as dilute alkali.

It is assumed that the desoxyribonucleic acid of the nuclei is responsible for gel formation. The fundamental reactions involved are thought to be as follows:

1. Nuclei prepared at low pH in aqueous media:
    a) $\text{H-DNA} + \text{NaOH} \longrightarrow \text{Na-DNA} + \text{H}_2\text{O}$.
    The Na-DNA is the gel-forming substance.
    b) $\text{H-DNA} + \text{NaCl}$—no reaction.
2. Nuclei prepared at pH 6.0 to 7.0 in aqueous media or by the Behrens technique:
    a) $\text{Hs-DNA} + \text{NaOH} \longrightarrow \text{Na-DNA} + \text{Hs-OH}$.
    b) $\text{Hs-DNA} + \text{NaCl} \longrightarrow \text{Na-DNA} + \text{Hs-Cl}$.
    Again the Na-DNA is the gel-forming substance.

In these equations, H-DNA stands for free desoxyribonucleic acid; Hs stands for histone, and Hs-DNA for the nucleohistone.

Nuclei prepared at pH 6.0 from normal rat liver by the use of very dilute citric acid do not form a gel, although they yield a highly polymerized, easily extractable sodium salt of desoxyribonucleic acid. The sodium salt of the desoxyribonucleic acid of nuclei capable of forming gels is, on the other hand, difficult or impossible to extract and it is thought that the latter type of nucleic acid represents a hitherto unrecognized "native" nucleic acid present in the intact cell, whereas desoxyribonucleic acid extracted even by mildest methods thus far available represents the product of some kind of intracellular autolysis or degradation.

A New Analytical Method for Adrenal Cortical Hormones

Robert B. Burton, Alejandro Zaffaroni, and
E. Henry Keutmann, ***University of Rochester***
(Introduced by George H. Whipple)

An adaptation of the technique of paper partition chromatography, utilizing nonaqueous solvent systems, is the basis of a new method for analysis of adrenal cortical hormones. The procedure permits separation and identification of microgram quantities of the individual cortical hormones in mixtures of known compounds, and in urinary and adrenal extracts.

Evidence will be presented which indicates the presence of Kendall's Compound E and 17-hydroxycorticosterone in extracts of urine from normal individuals.

Estimation of Physical Fitness

Robert A. Bruce, Frank W. Lovejoy, Jr., Paul N. G. Yu,
Raymond Pearson, and Marion McDowell
University of Rochester
(Introduced by George H. Whipple)

A preliminary appraisal of the estimation of physical fitness from cardiorespiratory measurements during a standardized stress of exercise has been made in healthy normal subjects, as well as in patients with a variety of diseases, especially of the heart and lungs. The method involves a battery of simultaneous and continuous observations of ventilatory, respiratory, and circulatory performance, including electrocardiographic changes, before, during, and after walking on a motor-driven treadmill at a moderate rate for a fixed period of time, or to the limits of tolerance. The duration of the walking effort times the average respiratory efficiency during exercise divided by the total pulse for the first three minutes of recovery equals the fitness index. This index shows a satisfactory correlation with clinical performance and symptomatic distress in ambulatory patients with disease. The spectrum of results ranges from complete and total disability in abnormals to better than average performance in normals. The limiting factors to physical fitness are chiefly circulatory; accessory studies in various patients provide further insight into these mechanisms.

The Work of Breathing

Wallace O. Fenn, Arthur B. Otis, and Hermann Rahn
University of Rochester

During breathing, the respiratory muscles do work in overcoming the elastic forces of the lungs and chest, viscous resistance of the air and tissues, turbulence of the moving air, and inertia. Measurements have been made to determine how the total work of breathing is subdivided among these various fractions. From such data, the respiratory apparatus can be described as a mechanical system. For any given minute volume of ventilation of the lungs this system has a frequency that is optimal (in the sense of minimal work), because if the frequency is too slow the elastic work becomes very great and if the frequency is too rapid much work is wasted in ventilating the dead space (air passages to the lung). Calculated optimal frequencies agree reasonably well with the frequencies observed in normal breathing. The theoretical maximal work that can be done by the respiratory muscles has been estimated on the basis of direct measurement of pressures that can be developed by the chest at various volumes and by calculation from anatomical data assuming that the respiratory muscles have properties similar to those of other skeletal muscles. Good agreement was obtained between the results of the two methods.

Hemolytic Anemia in Newborn Dogs Due to Absorption of Isoantibody from Breast Milk During the First Day of Life

Richard M. Christian, Donald M. Ervin, Scott N. Swisher, William A. O'Brien, and Lawrence E. Young
University of Rochester
(Introduced by George H. Whipple)

Four different antigenic factors have thus far been identified serologically in dog erythrocytes. One of these which may conveniently be called the "Do factor" appears to be somewhat analogous to the Rh factor of human red blood cells. Dogs lacking this factor in their red corpuscles are accordingly labeled "Do-negative" and those whose cells contain this factor are called "Do-positive."

Do-negative bitches that have been immunized by transfusions of Do-positive blood develop Do-antibodies that appear in high concentration in the colostrum after pregnancy and persist for several weeks in the breast milk. Experience with nine litters has shown that Do-positive puppies regularly develop hemolytic anemia if they suckle such an immunized dam during the first day or two of life. The lack of antibody absorption from milk after the second day has not yet been explained. There is evidence that natural immunization of the dam by fetal red cell factors may occur during pregnancy, thus producing hemolytic disease in dogs similar to that recently discovered as a naturally occurring phenomenon in horses.

The Electronic Spectra of Sulfur Hexafluoride

A. B. F. Duncan, *Department of Chemistry, University of Rochester*
(Introduced by W. A. Noyes, Jr.)

The electronic transitions of lowest energy in SF_6 were found to lie far in the vacuum ultraviolet region. The transition of lowest energy is at 1054 A, and a few additional transitions were observed below a strong continuous absorption, which begins at about 815 A.

A theory of the electronic energy levels has been developed, based on the method of molecular orbitals. The orbitals employed were linear combinations of fluorine and sulfur atomic orbitals, chosen with regard to the established octahedral symmetry of SF_6. The relative energies of the orbitals are computed in terms of integrals over atomic orbitals of the Slater form. Use was made of the experimental S–F distance and relative electronegativities of the atoms, but no other experimental data were available. Probable transitions of lowest energy are predicted, with estimates of the corresponding intensities.

Vapor-Liquid Equilibria in Synthetic Rubber Latex-Monomer Systems

O. E. Dwyer, L. C. Liberatore,[3] and W. A. Gleich[4]
Department of Chemical Engineering, The University of Rochester
(Introduced by W. A. Noyes, Jr.)

Two systems were studied—styrene/latex and α-methyl styrene/latex. The styrene/latex system could be more completely described as the styrene-polymer-water system, since the latex was essentially an emulsion of soap-stabilized butadiene-styrene copolymer in an aqueous medium which was more than 99.9% water. Similarly, the AMS/latex system could be described as the AMS-polymer-water system, where the polymer is actually a copolymer of butadiene and α-methyl-styrene.

The chemical and colloidal natures of the systems were such that a static, rather than a dynamic, method of equilibrium measurement had to be used. Data were obtained over temperature ranges of 40–95° C for both systems, styrene-polymer ratios up to 0.17, and AMS-polymer ratios up to 0.30. The experimental data agree quite well with vapor-liquid equilibria calculated on the basis of theoretical considerations. During and since the war, considerable advances have been made in understanding the thermodynamic behavior of polymer-solvent systems. Experimental measurements, particularly swelling measurements, combined with statistical mechanical treatment, have led to expressions for entropy and enthalpy changes in solvent-polymer interaction.

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[3] Present address: Taylor Instrument Co., Rochester, New York.

[4] Present address: Shell Chemical Corporation, Houston, Texas.

Curariform Activity and Chemical Structures[5]

V. Boekelheide, *University of Rochester*
(Introduced by W. A. Noyes, Jr.)

The use of drugs having curariform activity in the treatment of certain spastic and hyperkinetic disorders has demonstrated the need for a satisfactory drug of this type. An investigation of certain synthetic and natural drugs has been undertaken in the hope of relating curariform activity to chemical structure.

The compounds, prepared for study as possible peripheral curaiform agents, have included derivatives of piperidine, the tetrahydro-β and γ-carbolines, quinolizidine, benzyltetrahydroisoquinoline, and indolylmethyltetrahydroisoquinoline. Of these the indolylenethyltetrahydroisoquinoline derivatives showed the highest activity, which is of interest in view of their possible relationship to the calabash curare alkaloids.

In regard to compounds causing muscular relaxation through a central effect, several interesting results were obtained. It was found that β-erythroidine, a peripheral agent, is converted by acid to a derivative, apo-β-erythroidine, which has a central action of long duration. It was also discovered that a group of compounds of rather simple structure, derivatives of 4-hydroxymethyl-1, 3-dioxolane, have high activity as central agents in effecting muscular relaxation.

The Formation and Structure of Some Vinyl-derived Polymers with Heterocyclic Rings

L. M. Minsk, *Eastman Kodak Company*
(Introduced by W. Albert Noyes, Jr.)

Two polymers containing heterocyclic rings derived by reaction upon preformed linear polymers will be discussed. Though purely synthetic in nature, these have certain physical properties found in naturally occurring materials. The method of preparation will be given and some proof of structure presented. The first of these polymers belongs to the family of ester-lactones and is derived from poly-α-chloroacrylic acid by reaction with an alcohol. It has certain of the physical properties of cellulose and cellulose esters, as well as a structure which in one particular respect is related to cellulose. The other is a highly imidized polyacrylamide, whose aqueous solutions will, under suitable conditions, yield thermally reversible gels. The general phenomenon of gelation, viewed from the behavior of this polymer, will be discussed.

Problems in the Experimental Study of Flash Burns

Herman E. Pearse, *University of Rochester*
(Introduced by Wallace O. Fenn)

The brief exposure to a high intensity of thermal energy causes a lesion called a "flash burn." This was first seen at Pearl Harbor, but its importance was not fully appreciated until the study of the atomic bomb casualties at Nagasaki and Hiroshima; there were approximately 68,000 cases of burns at Hiroshima alone. This tremendous clinical problem needs further experimental study.

We have succeeded in creating the lesion both by igniting an inflammable substance and by using a large carbon arc with a shutter mechanism.

This discussion deals with the problems of devising suitable sources, of measuring the energy and spectrum they create, of calibrating the energy delivered, of analyzing the threshold of the energy and its spectral components in burn production, of determining the time-temperature relationships of these, and finally of comparing the flash burn with the ordinary low temperature burn from the standpoints of pathology, bacteriology, the systemic effects on protein and fluid changes, and mortality.

The Role of Glomerular Filtration Rate in the Pathogenesis of Edema

Robert F. Pitts, *Syracuse University*
(Introduced by Eugene F. DuBois)

About 20% of the weight of the body is extracellular fluid, i.e., a balanced salt solution which either circulates rapidly through the vascular system as the liquid blood plasma (about one-quarter of the total) or slowly through the tissue spaces between the cells as interstitial fluid (about three-quarters of the total). The fact that the weight of a normal individual remains constant from day to day despite wide fluctuations in the quantity of salt and water ingested is due to the fact that his kidneys excrete each day just enough of these components of the extracellular fluid to maintain balance. The capacity of the normal kidneys to compensate for fluctuations in intake is remarkable. In heart disease, in kidney disease, in liver disease, and, in truth, in all diseases characterized by weight gain due to fluid logging (storage of excess extracellular fluid as edema) the kidneys exhibit a reduced capacity to compensate for fluctuations in intake, especially of salt. Salt and water are retained and are stored in the highly elastic interstitial fluid compartment.

It is assumed that two disabilities of kidney function account for water and salt retention in edematous states: a deficient formation of a filtrate of the blood plasma in the glomerular tufts (the initial stage of urine formation) and excessive absorption of water and salt from that filtrate as it passes through the kidney tubules. Diuretics used clinically to promote the excretion of edema fluid act by partially blocking this latter tubular absorptive process. Although a few years ago the factor of reduced glomerular filtration was emphasized as a cause of edema, the tendency today is to emphasize tubular overabsorption and even to deny the significance of glomerular filtration.

In animals it is possible to vary glomerular filtration at will by constricting the blood supply to the kidneys and thus reducing the pressure head upon which filtration depends. When filtration is so reduced there is an immediate reduction in the excretion of salt and water. This disability is immediately reversible on removing the constricting clamp. The degree of reduction in filtration

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[5] Aided by a grant from the National Foundation for Infantile Paralysis.

rate necessary to produce this disturbance in salt and water excretion is no greater than that which is observed clinically in diseases characterized by edema. It has been observed clinically that in patients who have very low filtration rates, diuretics are relatively ineffective in promoting the excretion of salt and water. In animals, constriction of the renal blood supply reduces the effectiveness of diuretics very greatly. It is concluded that insofar as filtration rate is reduced in disease it will adversely affect the capacity of the kidneys to compensate for fluctuations in salt and water intake and will favor retention as edema. A reduction in filtration rate will also reduce the effectiveness of diuretic agents. It is admitted that reduced filtration rate is only one of several significant factors in fluid retention and resistance to diuretics.

Conference on the Ultracentrifuge

Duncan A. MacInnes
Rockefeller Institute for Medical Research

A group of 21 workers interested in the ultracentrifuge met under the auspices of the National Academy of Sciences for a three-day conference June 14-16, 1949, at the Ram's Head Inn, Shelter Island, Long Island. The program of discussion was arranged around the formula for interpreting ultracentrifuge results:

$$M = \frac{RTs}{D(1-PV)}$$

in which M is the molecular weight of, for instance, a protein, s is the sedimentation velocity, D the diffusion coefficient, V the partial specific volume, P the density of the solution, and R and T the gas constant and absolute temperature respectively.

The determination of s involves problems of centrifuge design. The use of magnetically supported and driven rotors was forecast, and, also, interference methods for following boundary movements.

Great progress was reported in the precision determination of diffusion coefficients, D, by widely differing methods.

The precision of the values of M is largely dependent upon the accuracy of the product, PV, which depends upon density measurements of solutions. A magnetic float method for this determination was reported, as was also a procedure for obtaining the temperature, T, of the rotor while turning at high speeds.

An outstanding result of the conference was the agreement that the trend of research will be away from high speeds, and toward a greater use of equilibrium, as against the sedimentation velocity, method. An important suggestion concerning the utilization of states approaching equilibrium in obtaining molecular weights was advanced.

Some Recent Approaches to the Experimental Study of Human Fatigue

Leonard Carmichael, John L. Kennedy,
and Leonard C. Mead, ***Tufts College***

The paper briefly reviews some current definitions of fatigue from the standpoint of physiology and psychology. Experimental studies are then reported on the measurement of performance (primarily visual or motor) under various conditions of stress and prolonged work. Among the conditions studied were the following: (1) eye movement and reading accomplishment during six hours of continuous reading; (2) performance of tasks requiring stereoscopic vision, eye-hand tracking, and "lookout" performance, all during three-day period of work with only brief and irregular rest periods; (3) eye movements, various visual tasks, reaction time, steadiness, and certain psychological processes in subjects who worked for fifty hours without sleep; (4) the effect of a three-day sleep deficit on performance in a complex task requiring continuous and simultaneous coordination of several sensorimotor operations.

A generalization which pertains to all the experimental results in the experiments outlined above is that the subjective indices of fatigue are dependent upon the motivation of the individual being studied. This motivation or eagerness or willingness to continue to exert oneself is not a continuous function of the duration of work. Rather, the experiments indicate the presence of high motivation at any stage during the long continued performance of a task will allow the behavior under observation to appear in an essentially unchanged form from that recorded when the subject is "unfatigued."

An electronic apparatus has been developed in an attempt to measure a physiological variable (muscle spike output from the supraorbital musculature) which shows promise as an indicator of the general alertness of subjects while performing tasks during long periods of time. It is tentatively suggested that the early stages of certain states of fatigue in monotonous work may be identified in terms of alterations in the integrated electrical output of muscle spikes from localized muscle areas. There is some evidence that the fluctuations or periodicity noted in this electrical output have a psychological correlate in the temporary blocks in "mental" or physical work which have been observed in our own experiments and in recent experiments by other investigators.

A Hypothesis Regarding the Origin of the Movements of the Earth's Crust

Harold C. Urey
Institute for Nuclear Studies, University of Chicago

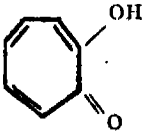
If it is assumed that the radioactive content of the core and mantle of the earth are respectively equal to the radioactive content of the iron and stone meteorites, it is found that the earth must be getting warmer. It is assumed therefore that this is the case, that the earth was formed in a cold condition, and that to a first approximation it was a uniform mixture of iron and stony phases throughout, with a possible modification at the center to be mentioned later. Rough calculations show that the gravitational energy stored which would be dissipated in the formation of the present core of the earth is greater than the radioactive heat that has been generated in 2 billion years from all radioactive materials. Kuhn and Rittman have shown that iron droplets cannot sink in the present mantle of the earth because of its high viscosity, but it is maintained here that the iron flows to the center of the earth through channels due to the wetting of some constituent of the stony phase by the iron phase. The falling of the iron through the mantle generates a large amount of heat, and if there is a sharp layer some distance below the crust of the earth, perhaps at the Rapetti discontinuity, high temperature silicate phase is generated at depth. This leads to convection in the outer mantle of the earth and the formation of mountains, as has been postulated by Griggs. The forces are adequate to account for the formation of mountains and roughly the time of convection estimated is approximately that required by geological evidence, being somewhat too rapid, using a viscosity of 10^{20} poise for the outer earth.

The chemical differentiation in the crust can be explained as separation of olivene from other constituents by sinking in a molten magma at a temperature in the neighborhood of 1500–1600° A. This temperature also is appropriate for explaining the constituents of the atmospheres of Mars, Venus, and the earth on the basis of chemical reactions taking place at this temperature and below. The difference in density of the moon and the earth may be explained if low density material condensed first and higher density material (iron) later. This hypothesis leads to an initial structure of the earth with a core of moon-like material surrounded by a layer of silicate and iron phase. If this central core remained at the center of the earth for some time, then on rising to the surface it should have produced the Pacific Basin, with its floor of basaltic rock. It is interesting to speculate upon what time in the earth's geological history this may have occurred.

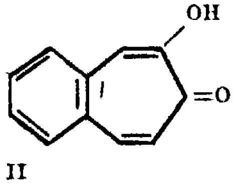
Studies on the Structure of Colchicine[6]

D. S. Tarbell, ***Department of Chemistry, University of Rochester***
(Introduced by W. A. Noyes, Jr.)

The alkaloid colchicine is of biological interest because of its antimitotic action, but its chemical structure is not completely elucidated. Evidence will be presented to support the suggestion of Dewar that colchicine contains the "tropolone" structure (I) in ring C. This evidence



I



II

is based on periodic acid oxidation of hexahydrocolchiceine, and on the study of infrared absorption spectra of colchicine derivatives and other compounds known to contain the tropolone ring. The synthesis of simpler compounds containing the tropolone ring has been studied, and a compound believed to be benztropolone (II) has been obtained by condensation of hydroxyacetone with phthalaldehyde; a by-product in this condensation has been proved to be phthiocol (2-hydroxy-3-methyl-1,4-naphthoquinone). The chemical behavior of II will be discussed in relation to that of the colchicine series.

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[6] Aided by a grant from the National Institutes of Health.

TECHNICAL PAPERS

General Method for Paper Chromatographic Analysis of Reducing and Nonreducing Carbohydrates and Derivatives

E. Pacsu, T. P. Mora, and P. W. Kent

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The paper chromatographic procedure for the investigation of reducing sugars (*3, 4*) or their methylated derivatives (*1, 2*) depends for its success on the ease with which the substances under test will reduce certain inorganic ions at elevated temperatures. It has been found that not all ketosugars or disaccharides will bring about reduction. Efforts have been made to find a more general method of developing chromatograms in order to detect these nonreducing substances. It was proposed by Partridge (*4*) that acidic naphthoresorcinol could be used to detect such carbohydrates. In the course of investigation in this laboratory of complex mixtures of these substances, we have found the use of acidic reagents and of excessive drying undesirable. Experiment showed that excellent results can be obtained by developing the chromatograms with aqueous potassium permanganate (1%) containing sodium carbonate (2%). The chromatograms were removed from the chamber and dried at room temperature, or rapidly at 100° C. By spraying with the permanganate reagent, the bands appeared, with varying rapidity, as striking yellow zones on purple background, even at room temperature. In a short time, as the chromatograms dried, the spots took up their final color as gray regions on a brown background. In view of this change of color, it was expedient to mark the position of each band as soon as it was developed.

Using the partitioning solvents as specified by Partridge (*3, 4*)—viz., butanol (40%), ethanol (10%), water (50%)—it was possible to separate sugar alcohols, glycosides, and reducing and nonreducing sugars. Attempts to separate acetylated or partly methylated sugars using this modified procedure were not successful, since these substances did not readily reduce permanganate.

In an attempt to obtain a better separation of trisaccharides and the higher sugars, the usual solvent mixture was reversed, i.e., the aqueous layer was used as the eluting solvent in place of the usual butanol layer. Some separation was indeed obtained, but this was accompanied by a considerable spreading of the bands. However, some substances, e.g., streptomycin, which were immobile in the Partridge procedure, migrated rapidly and could be readily developed by the permanganate reagent. Further investigation of this approach would be profitable.

TABLE 1

R$_f$ VALUES DETERMINED ON WHATMAN NO. 1 PAPER, USING BUTANOL LAYER AS THE ELUTING SOLVENT (DOWNWARD MIGRATION). TEMPERATURE ∽ 25° C.

Name of compound	R$_f$ value
a-Methyl glucoside	0.35
a-Glucose penta-acetate*	0.969
Mannitol	0.08
Sucrose	0.02
Melibiose	0.009
Lactose	0.013
Melezitose	0.01
Glucosamine	0.052
n-Carbobenzoxy-2-amino-a-methyl glucoside*	0.816
Methyl xylofuranoside	0.449
Salicin	0.526
Turanose	0.042
Potassium glucose-1-phosphate	0.003
D-Ribose	0.269

* Test substance was applied to the paper in ethanolic solution and dried before placing in the chamber.

In Table 1 are shown the R$_f$ values of a series of compounds determined by using potassium permanganate.

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Paper Chromatography of Proteins and Enzymes[1]

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The original work of Consden, Gordon, and Martin (*1*) on the paper chromatography of substances of biological importance has been extensively developed, and a large literature has accumulated which cannot be adequately summarized here. So far as we are aware, however, there is no report of the separation of protein molecules by paper chromatography.

We wish to report preliminary results of an investigation of the paper chromatography of proteins and enzymes. Our work shows that it is possible to study the movements of proteins on paper, and to determine the conditions under which proteins may be separated by this means. It is also possible by the same means to bring about separation of the components of enzyme mixtures, and to study enzyme activity, manometrically, on paper.

Our work has been greatly facilitated by the use of hemin as a "marker," the presence of a protein-hemin complex on paper being easily shown by the benzidine-hydrogen peroxide reagent. We employ buffer and aqueous salt solutions, instead of nonaqueous solvents, as developing agents.

The technique employed is that of Williams and Kirby (*2*), which involves chromatography by capillary ascent. Whatman No. 1 sheet filter paper has been used throughout this work. When drying is complete, the paper is streaked with freshly prepared benzidine reagent, using a small paint brush. Color development is immediate and intense, and should be photographed almost immediately, as a background color develops gradually and this tends to obscure the color from the protein-hemin complex.

Protein solutions. Ten mg crystalline protein is dissolved in 1 ml of distilled water or saline and to this is added 0.02 ml of 2.0% hemin, which has been dissolved in 3% sodium bicarbonate solution. Aliquots of 0.01–0.02 ml are used for chromatography.

Developing solutions. A search for suitable developing solutions has resulted in the exclusive use of aqueous solutions of salts and buffers. For buffers, 50 ml of a M/5 solution of the salt is adjusted to the desired pH with a *N*/5 solution of HCl or NaOH and the volume is made up to 200 ml. In the case of acetate-HCl buffers, normal solutions are used. Salt solution concentrations are usually in the region of 1–2%.

The use of organic solvents gave unsatisfactory results. *n*-Butanol saturated with water allowed extremely little movement of proteins and favored the formation of an immediate, deeply colored background on application of the benzidine reagent. Aqueous solutions of ethylene glycol, propylene glycol, ethanol, or acetone induced maximum or near maximum movement. All proteins tested moved about the same distance under these conditions.

Benzidine reagent. The preparation is made as follows: Equal volumes of saturated alcoholic benzidine solution and 3% hydrogen peroxide are mixed and made acid with glacial acetic acid. Fresh reagent must be prepared daily. Poor color development results if the hydrogen peroxide stock solution has decreased in strength.

Color development with protein-hemin complexes is generally blue, but may be purple, brown, or green. Some salts, e.g., magnesium sulfate and sodium phosphate, interfere with color development. Citrate, glucose, trisodium phosphate, and potassium hydrogen phthalate at some pH values give rise to a deep purple color.

Background color development varies considerably, depending on the ease with which the benzidine reagent is oxidized. Acid pH values tend to retard background color development, while alkaline pH values give rise to a deeply colored background. Photographs are made of the chromatograms at the optimal development of color. It is necessary to photograph the chromatogram while the paper is still damp.

Hemin. A stock solution of 2% hemin in 3% sodium bicarbonate solution was prepared and 0.02 ml was added to 1 ml of the protein solution. In the proteins studied,

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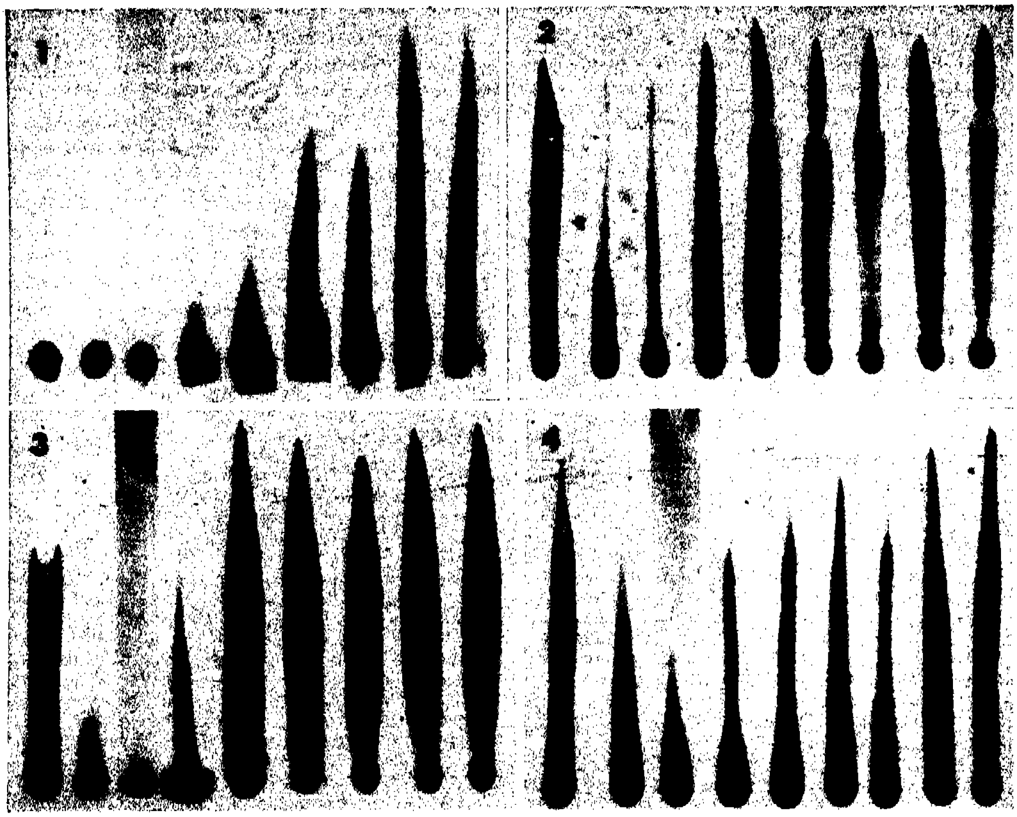
[1] Aided by a grant from the National Cancer Institute of Canada.

[2] Holder of a Canada Packers Research Fellowship of McGill University.



FIGS. 1–4. Composite photographs of unidimensional chromatograms of hemin and protein-hemin mixtures, showing the effects of changes of pH from 2 to 10 at 1-pH-unit intervals, from left to right. 1. Hemin control. 2. Bovine serum albumin-hemin. 3. β-Lactoglobulin-hemin. 4. γ-Globulin-hemin.

it has been observed that the presence of hemin does not alter the R_f value of the protein.

A control hemin chromatogram, in which 0.02 ml is diluted to 1 ml with distilled water, shows that movement is nil up to pH 5 and very slight at pH 6, and that it increases considerably above this pH (Fig. 1). Some developing solutions, among them those containing bicarbonate, glucose, sucrose, glycine, methionine, alanine, and urea, allow maximum or near maximum movement.

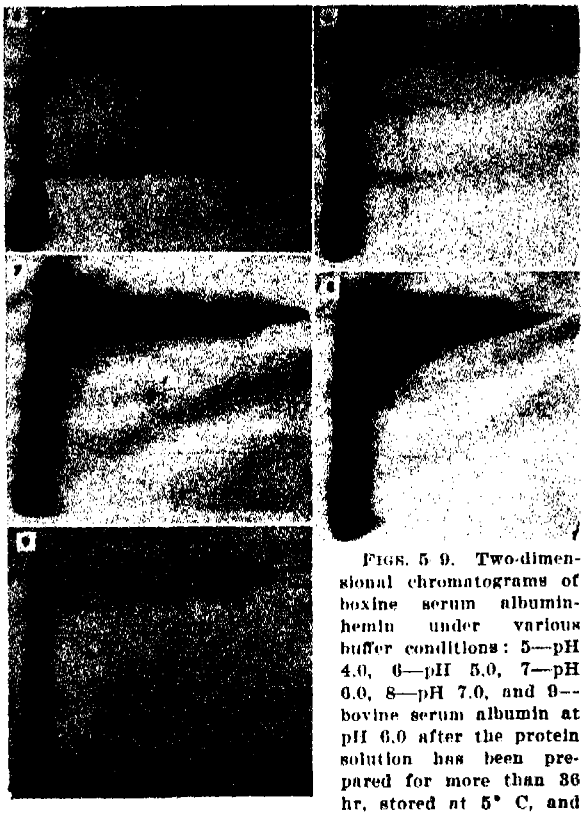
It has been found that some proteins and protein mixtures such as egg albumin, pepsin, papain, diastase, and urease will not combine with hemin. However, if hemin is added to a solution of these proteins, chromatographed, and streaked with the benzidine reagent, it is noticed that hemin remains at or near the point of origin (below pH 7). If the paper is allowed to stand for some time at room temperature, it is found that the background will color (to varying degree, depending on the nature of the salt in the developing solution), and a colorless spot will appear. It will be shown later that this colorless region actually contains the protein. Presumably the protein retards background color development and so produces a colorless "spot." Casein and β-lactoglobulin give rise to colorless spots or fractions up to about pH 5, and to deep blue fractions at higher pH values. γ-Globulin and bovine albumin give rise to colored fractions over the entire pH range (see Figs. 2, 4).

Time of development. It has not been found necessary to allow the solution front to advance beyond 20–25 cm, which requires about 90 min. The composition and shape of the chromatogram is determined within the first 20 min, and further development results in a more easily evaluated fraction. A complete two-dimensional chromatogram may be obtained within 5 hr.

The protein chromatogram. A long, rather narrow finger is formed, provided that the protein combines with hemin. The color intensity varies along with the finger, depending on the pH with which it is developed. Bovine albumin-hemin at pH 2 shows two intensely colored fractions inside the finger (Fig. 2). It may be shown that the greatest portion of the protein is concentrated in the leading fraction, and only traces remain in the finger.

One-dimensional chromatography results in the formation of a yellow-colored solution front, which fluoresces in ultraviolet light, and at pH 2, two separated bands appear at the leading edge of the chromatogram. Two-dimensional chromatograms result in a series of villus-like structures appearing in the second dimension. The presence of proteins on the paper tends to repress the full movement of those structures that are in the immediate vicinity of the protein.

Effect of pH. The variation of protein movement with change of pH seems to be much the same for all the proteins studied. At very acid pH values, e.g., pH 2, there



FIGS. 5–9. Two-dimensional chromatograms of bovine serum albumin-hemin under various buffer conditions: 5—pH 4.0, 6—pH 5.0, 7—pH 6.0, 8—pH 7.0, and 9—bovine serum albumin at pH 6.0 after the protein solution has been prepared for more than 36 hr, stored at 5° C, and then chromatographed with citrate in the first dimension and fumarate in the second dimension.

usually appears a well-defined leading section. In the region of pH 4–5 there is often little or no movement, and where movement does occur, no well-defined leading fraction occurs. Above this pH, a large, well-defined spot appears, which is quite constant in size. The R_f values depend upon pH in a similar way, being least around pH 4, which is near the isoelectric point of some of the proteins. R_f values and sizes of the spot are remarkably constant from pH 6 upwards.

Chromatography of bovine serum albumin-hemin complex. The R_f value of a bovine albumin-hemin complex is least in the region of pH 4. At pH 2, there appear two separated fractions inside the finger. This is also true at pH 3 but the spots are smaller and less intensely colored. From pH 5–12, there is a well-defined leading fraction, quite constant in size and position (Fig. 2).

In two-dimensional chromatograms, at pH 4, there is movement in the first dimension only (Fig. 5). At pH 5, with citrate-NaOH in the first dimension, and phthalate-NaOH in the second dimension, two separate fractions are obtained (Fig. 6). At pH 5.5 with citrate-NaOH in the first dimension and acetate-HCl in the second dimension, there appear two main fractions and a minor fraction. At pH 6 and 7 there is a single fraction appearing in the second dimension (Figs. 7 and 8).

It has been observed that if bovine serum albumin is allowed to remain in solution for a period of more than 36–48 hr, multiple fractions, sometimes as many as four, will appear. Various combinations of buffers have shown the separation of these fractions at pH 6 (Fig. 9).

It is apparent from these results that the crystalline bovine albumin which we have used behaves, when a solution is freshly prepared, as a homogeneous protein at pH 6–7, whereas two components are present at pH 5–5.5.

A private communication from Dr. G. Perlmann, to whom we are indebted for our supply of crystalline bovine serum albumin, states that this protein is homogeneous electrophoretically from pH 3.0 to 3.8 and pH 5.0 to 10.0. In the region of the isoelectric point the protein separates into two distinct electrophoretic components. This phenomenon seems to be a property of most serum albumins and indicates that crystalline albumin preparations contain several closely related proteins. Paper chromatography appears to confirm and may extend the results of electrophoretic analysis.

Chromatography of β-lactoglobulin-hemin complex. It is found that the union between β-lactoglobulin and hemin is not complete if the pH is 5 or less, i.e., the leading fraction is colorless. From pH 6 upwards, the complex shows as an intense blue. Thus the formation of a complex between this protein and hemin is dependent upon pH. R_f values show much less variation than those of bovine albumin. The R_f value is least at pH 4 and greatest at pH 6, where it is 0.86. All other values lie very close to 0.80 (Fig. 3).

Two-dimensional chromatograms between pH 6 and 7 demonstrate that this crystalline protein is not homogeneous. The use of citrate-NaOH in the first dimension and tartrate-NaOH, phthalate-NaOH, or acetate-HCl in the second, shows that there are a number of fractions in this sample. However, their complete separation under these conditions has not yet been achieved (Fig. 10).

We are again indebted for this sample of protein to Dr. Perlmann, who states that in 1945 this protein was found to be a mixture, there being two distinct electrophoretic components in the pH range 3.7–5.0, and also between pH 6.0 and 7.0.

Chromatography of human γ-globulin-hemin complex. It appears that γ-globulin, at the concentrations used, does not combine completely with hemin over the entire pH range. At each pH value, some combination takes place, but it is evident that from pH 3 to pH 8, there is a portion that does not combine, the amount of this portion decreasing with an increase in pH.

At pH 2, γ-globulin gives rise to two separate fractions inside the finger, in much the same manner as that shown by bovine albumin, but the fractions are smaller in size. Movement is least at pH 4. R_f values are 0.78 at pH 2.0 and 7.0, and increase to 0.81 at pH 10 (Fig. 4).

A two-dimensional analysis shows an excellent separation of two components of γ-globulin, the separation occurring at right angles. The first developing solution may be a phthalate-NaOH buffer at pH 6.0, 5% ammonium sulfate or 2% oxalic acid, followed by 2% tartaric acid in the second dimension (Fig. 11).

This protein, according to Dr. G. Perlmann, who kindly provided the sample, consists of one main electrophoretic component (96% of the total protein content), and it shows a marked boundary spreading, which indicates lack of homogeneity.

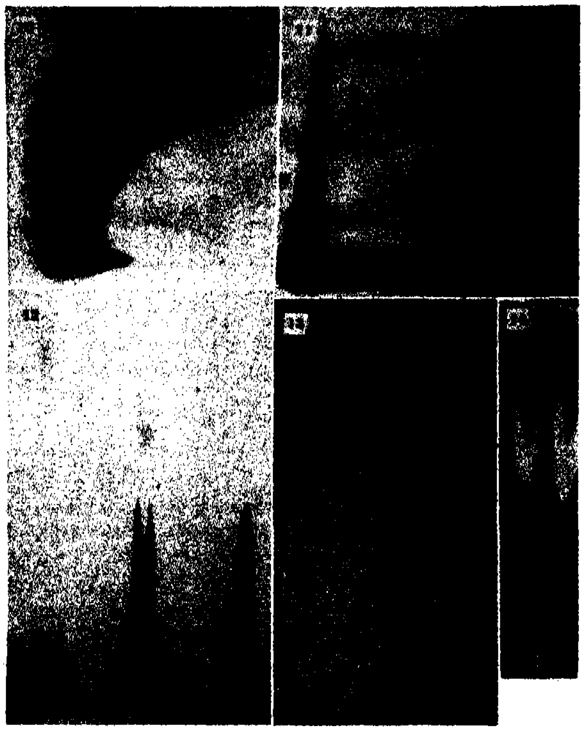


FIG. 10. Two-dimensional chromatograph of *β*-lactobulin-hemin at pH 6.5.

FIG. 11. Two- dimensional chromatogram of *γ*-globulin-hemin, using a phthalate buffer at pH 6.0 in the first dimension, followed by a 2% tartaric acid in the second dimension.

FIG. 12. Papain, papain-casein, and casein, in that order, developed with 2% succinic acid as the developing solution.

FIG. 13. Papain-bovine serum albumin, diastase-*β*-lactoglobulin, and *β*-lactoglobulin developed in a phthalate buffer at pH 5.0. There is no separation.

FIG. 14. Egg albumin developed in distilled water at pH 6.4. The resulting white spot was eluted, and identified by serological means.

Chromatography of enzyme preparations. Some preliminary work has been done on the movement of enzyme solutions. Preparations of pepsin, papain, malt diastase (commercial preparations from British Drug Houses, Ltd.) and urease (25-mg Urease-Dunning tablets) were used, and it was found that hemin will not combine with any of them. After streaking with the benzidine reagent and allowing the paper to stand for a time, it is observed that the malt diastase and papain preparations give rise to very well-defined, colorless oval spots. The urease preparation produces a vertical streak, but the pepsin preparation fails to show any definable movement. The papain preparation shows R_f values of 0.81 up to pH 3, which increase to 0.90 at pH 8.0–12.0. The malt diastase preparation shows a very constant R_f value over the entire pH range, varying only between 0.90 and 0.95, whereas the urease has an R_f value of 0.78 at pH 2, which increases to 0.85 at pH 3 and then gradually increases to 0.92 at pH 12. It seems likely that paper chromatography will be of service in the evaluation and examination of commercial enzyme preparations.

Chromatography of mixtures of proteins. One-dimensional chromatograms rarely separate a pair of proteins. We have succeeded, however, in separating components of a mixture of papain and casein, using 2% succinic acid as the developing solution (Fig. 12). The movement of papain is apparently retarded by the presence of casein. Other proteins have been run in combination with the preparations of papain and diastase, but no separations were effected (Fig. 13).

Chromatography of egg albumin. Crystalline egg albumin was used and, like the enzyme preparations already referred to, it will not unite with hemin. It appears as a colorless spot on a colored background (Fig. 14). It is barely detectable below pH 4, at which point it has an R_f of 0.60. This increases to 0.75 at pH 9.

The identity of the protein present in the colorless spot with egg albumin was shown by its ability to form a precipitin with a specific antiserum produced in a rabbit by albumin injections.[3] Precipitin formation was produced only by the solution of the substance contained in that part of the paper strip believed to contain the protein, as determined by the streaked control.

Our results prove that a solution of crystalline egg albumin may be chromatographed under the given experimental conditions, the position of the protein being indicated by a well-defined colorless region on a colored background. The protein present in this region reacts typically with an ovalbumin antiserum.

Chromatography of a urease preparation and the manometric estimation of urease on paper. The question arose as to whether enzymes will retain their catalytic activities if they are subjected to our chromatographic technique. A series of chromatograms was therefore set up for this purpose, the enzyme selected being urease.

The enzyme solution was prepared by grinding twenty 25-mg urease-Dunning tablets in a small mortar in 2 ml of a 2% cystein-glycine solution that had been adjusted to pH 6. It was then centrifuged for 15 min, and the supernatant solution was used for chromatography. Aliquots of 0.04 ml were applied to the paper by placing 0.02 ml on the paper, allowing it to dry, and adding another 0.02 ml. The developing solution was prepared by dissolving 2 g cystein hydrochloride in water and adjusting the pH to 6 with caustic soda solution, making the volume to 100 ml, and then adding 1 g glycine. This reagent should be prepared just prior to use. The solution was allowed to advance about 20–22 cm. The paper was then removed and allowed to stand at room temperature for a few min. While the paper was still damp, it was cut into 3-cm sections, starting 0.5 cm from the bottom of the paper. The boundaries were marked 7 mm on each side of the point of application of the aliquot.

Each section of filter paper was then cut into four parts, all of which were placed immediately in a Warburg manometric vessel with 3 ml acetate buffer at pH 5, and 0.2 ml 10% urea was placed in the side arm. As a control, a ten times dilution of the original supernatant was

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[3] This antiserum was kindly prepared for us by Prof. E. G. D. Murray, of the Department of Bacteriology, McGill University.

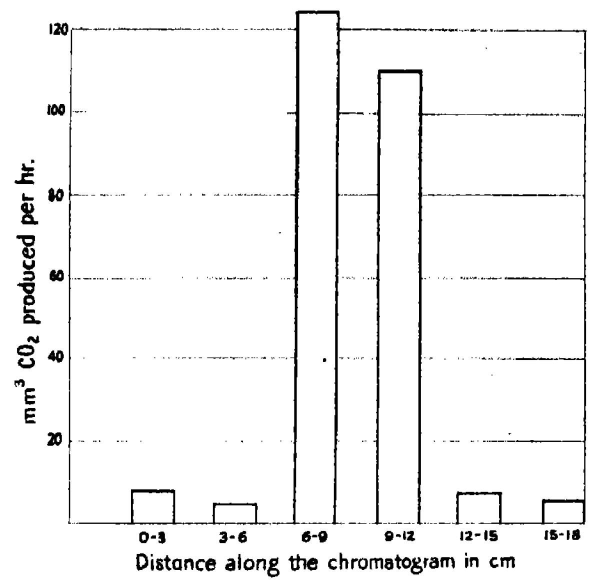

FIG. 15. Urease activity along the chromatogram.

used (diluted with physiological saline) and 0.4 ml of it placed in the Warburg vessel with 2.6 ml buffer and 0.2 ml 10% urea in the side arm. A period of 30 min was allowed for the contents of the vessel to attain thermal equilibrium (37° C). The urea in the side tube was then tipped into the vessels, and carbon dioxide output rate measured manometrically in the usual way for 1 hr.

The results show the existence of a distribution curve of urease on the paper strip. Traces of enzyme are left at the point of origin, but a fair proportion ascends the paper, whose maximum urease activity lies between 6 and 12 cm from the origin. On either side of the maximum there is a drop in enzymic activity. These results are shown in Fig. 15. If a parallel chromatogram is streaked with the freshly prepared benzidine reagent, it is found that the greatest extent of the colorless region on the colored background is 6–12 cm from the origin.

On assessing the activity of the urease over the entire strip, by adding together the activities of the various parts of the strip it is found that the total activity amounted to 85% of that expected from the amount of urease placed on the paper. Another assessment of the total urease activity over the entire strip showed a recovery of 110%, the assessment being made from a calibration curve previously prepared, relating activity (rates of CO$_2$ production) to the quantity of urease. These results show that urease activity is not diminished within experimental error by our chromatographic technique, and that movement of the urease molecule on filter paper can be followed. It is evident, however, from our preliminary results that metallic constituents of the filter paper may appreciably affect the rate of movement of urease and possibly other proteins. This needs more study.

Chromatography of human serum. A few experiments have been carried out on the chromatography of human serum. The results show the presence, at pH 6, of a complex mixture of hemin-reacting proteins. Three of the fractions appear to give R$_f$ values identical with those found with a preparation of crystalline human serum albumin. Human serum globulins do not seem to move appreciably in the second dimension. We estimate that, with our technique, between 6 and 10 protein fractions appear. This work is now being extended with a view to discovering whether paper chromatography of blood serum may be used for diagnostic purposes.

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Tetrazolium Chloride as a Test for Damage in Artificially Cured Peanuts

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The artificial curing of peanuts is being investigated in several Southeastern states as one phase of a mechanization program designed to reduce production costs and improve nut quality. Drying methods found to be practicable for certain other oil crops and for cereal crops could not be applied empirically to the peanut because of the uncertainty of curing effects upon flavor of nuts for the food trade and because of the heat- and moisture-insulating properties of the peanut shell. Large scale experiments on artificial curing of peanuts, therefore, have had to await results of preliminary trials.

In a series of exploratory curing tests at the Alabama Agricultural Experiment Station, using different drying temperatures and rates of air flow, the desirability of a quick test of curing effects upon peanut quality soon became apparent. It was evident that the standard tests of quality in sound, mature peanut kernels—free fatty acid percentage, iodine value, and germinability—all required more time and analytical apparatus than were practical for rapid estimates of heating effects upon peanuts. Furthermore, germinability could be used at time of harvest only for the Spanish variety of peanut. The runner variety, which constitutes the great bulk of the Alabama crop, germinates only after a period of dormancy of several weeks following harvest.

However, it was assumed that seed viability might be correlated with some of those properties of flavor and oil quality which characterize peanuts of high market value both at time of harvest and after storage. Successful use of tetrazolium salts as viability stains in seed germination experiments (*2, 3, 5, 7*), in determination of vitality in miscellaneous plant and animal cells and tissues (*6*), and in demonstration of injury by heat in stem tissues (*8*) and by freezing in maize (*1, 4*) suggested their possible application as a quick test for heat and drying damage in artificially cured peanuts. Preliminary results indicate that they may be so used.

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TABLE 1

EFFECT OF HEATING UNSHELLED SPANISH PEANUTS FOR 1 HR AT VARIOUS TEMPERATURES UPON VITALITY AS SHOWN BY TETRAZOLIUM CHLORIDE AND GERMINABILITY TESTS

Temperature of treatment °F.	Degree of injury shown by tetrazolium vitality test				Germinability
	Killed	Serious damage	Slight damage	Undamaged	
	%	%	%	%	%
115	0	0	3	97	92
130	0	0	4	96	93
145	0	0	4	96	92
150	0	2	8	90	81
155	4	69	21	6	46
100	100	0	0	0	0

The peanut seed is exceptionally well suited to the vitality stain technique. Porter *et al.* (*7*) pointed out the practical difficulty of interpreting vitality stain tests in some other leguminous seeds because the large, thick cotyledons are stained along with the rest of the embryo, thus requiring more time and care for making a separate analysis of the radicle and plumule. The peanut is unlike other common leguminous seeds in that the torpedo-shaped "germ" (embryonic axis including plumule, hypocotyl, and radicle) is quite readily detached from the cotyledons without overnight soaking or other preliminary treatment. Also, the plumule is well developed in the mature peanut seed, permitting more accurate prediction of normal shoot development than is possible with seeds of such legumes as soybeans (*7*).

Investigators (*2, 3, 5, 7*) have recommended soaking the seeds of other legumes in water for several hours or overnight before testing, and immersing them in the tetrazolium salt solution for several more hours before analyzing them. An accelerated test modified after Cottrell (*2*) was used for the peanut experiments described in this paper, in which the separated embryonic axis was held in warm water (115° F) for an hour, then immersed in a 2% solution of 2,3,5-triphenyl-tetrazolium chloride and incubated in the dark at 115° F for another hour, after which readings were made.

Following such treatment, the germs from green or naturally dried peanuts give a bright red stain to the plumule, as well as to the entire cross section of the interior of the hypocotyl and radicle. The surface cells of the hypocotyl and radicle show only light staining or none, but the heavily stained interior is plainly visible through them. In interpreting heating effects of artificial curing upon the peanut kernels in these studies, four criteria of staining were considered indicative of four degrees of damage. An unstained germ was judged to be evidence of complete killing. An unstained plumule of a germ, which otherwise showed red or pink coloring of the interior of radicle and hypocotyl, was considered to indicate serious heat damage. A pale red or pink staining of both plumule and radicle was interpreted as showing medium to slight curing damage. Peanuts undamaged by the artificial curing were believed to be those whose germs showed a bright red stain throughout, as previously described for the green or field-cured peanuts.

Table 1 presents results of the tetrazolium staining tests on unshelled Spanish peanuts (initial moisture range 22–25%) that were run immediately after each drying experiment was completed, and the corresponding tests of germinability were made on like peanut samples at a later time. The utility of the tetrazolium staining test in determining the temperature range in which serious heating damage in peanuts first occurs is evident from data in the table. Tetrazolium tests and germination counts for untreated peanuts showed essentially the same percentages as those listed for temperatures of 115, 130, and 145° F.

The studies to determine the relationship between vitality as shown by the tetrazolium staining reaction and chemical deterioration of the seeds, as indicated by free fatty acid percentage, were inconclusive for the number of tests made. However, there was strong evidence that the decline in seed vitality accompanying an increase in free fatty acids can be accurately estimated by a further refinement of the tetrazolium technique. It also has been shown by the author in other experiments, results from which are to be published elsewhere, that the first marked increase in the percentage of such undesirable physical properties of peanuts as slipping of skins and breaking of kernels during shelling appears in essentially the same temperature range (150–160° F), which has been shown here to be associated with the first rapid loss of viability. It therefore appears that the tetrazolium test may be used as an indirect measure of heating effects upon biological, physical, and chemical properties of peanut seeds.

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Radioiodine and Paper Chromatography Technique in the Study of Thyroid Metabolism[1]

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Preliminary studies in this laboratory employing the procedure of Fink, Dent, and Fink (*3*) with radioiodine and paper partition chromatography have indicated that several of the radioiodine products of unknown nature

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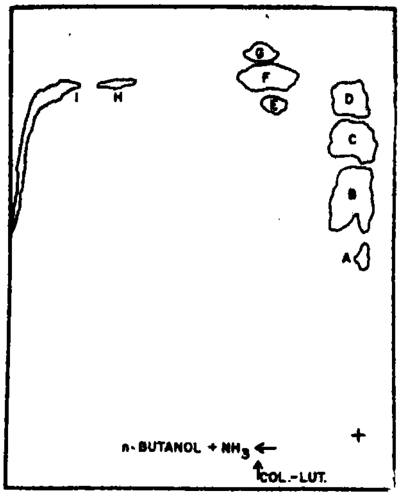
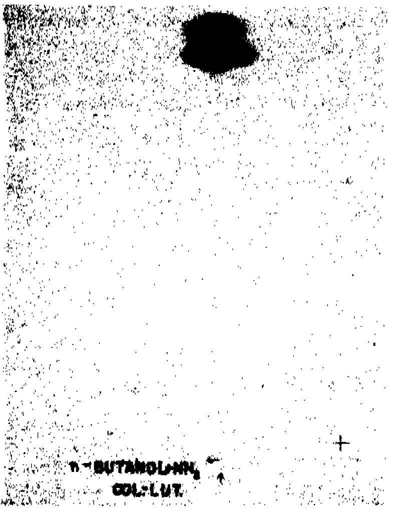
[1] Based in part on work under contract with the AEC, University of Rochester, Atomic Energy Project.





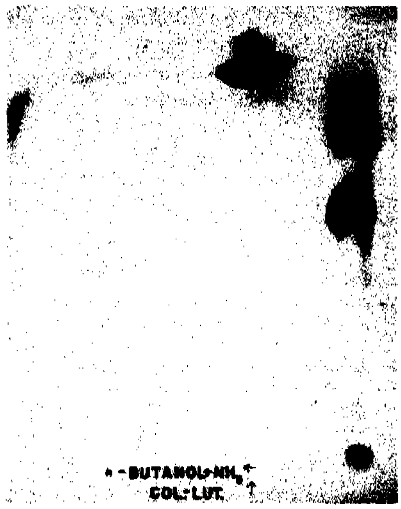


FIG. 1. Distribution on paper chromatogram of iodine-containing constituents obtained from thyroid hydrolyzate: A, unknown; B, diiodotyrosine; C, monoiodotyrosine; D, unknown; E, thyroxine; F and G, iodide; H, diiodothyronine (?); and I, unknown.

FIG. 2. Radioautograph of paper chromatogram run on NaI^{131}.

FIG. 3. Radioautograph of paper chromatogram obtained from alkaline hydrolysis of thyroid gland (48 hr following injection of NaI^{131}).

previously reported in thyroid hydrolyzate as well as the solvent artifact may have arisen from the interaction of radioiodide and the phenol solvent employed. This paper reports the results of a series of experiments aimed at characterizing the iodinated products of thyroid hydrolyzate using a paper partition procedure modified to avoid the interaction of radioiodide and the solvents employed.

The use of two-dimensional paper partition chromatography in conjunction with radioiodine in the study of thyroid metabolism has demonstrated the presence in thyroid hydrolyzates of thyroxine, mono- and diiodotyrosine, and several compounds of undetermined nature (*3*, *4*). Hird and Trikojus (*5*) have demonstrated the presence of thyroxine, diiodothyronine, and possibly triiodothyronine as ninhydrin-reactive products from the hydrolyzate of thyroprotein, using one-dimensional paper partition technique and a solvent consisting of an ammoniacal mixture of *n*-butanol and amyl alcohol.

Rats were given subcutaneously 50 μc of carrier-free I^{131} and sacrificed at 24, 48, and 72 hr. Thyroids were hydrolyzed with 8% $Ba(OH)_2$ for 24 hr in a sealed tube, the excess barium was removed by bubbling CO_2 through the solution, and the supernatant was placed directly on the filter paper. The precipitate was then extracted once with *n*-butanol and the filtrate placed on the paper over the previous spot. Approximately the equivalent of one thyroid gland was used for each paper chromatogram.

In the preparation of the two-dimensional chromatogram, *n*-butanol in an atmosphere of NH_3 was employed as one solvent, and a mixture of collidine and lutidine as the second solvent. Before use, all solvents were treated with a large excess of elementary iodine and then distilled to remove the resulting iodine-reactive products. The filter paper employed was Schleicher and Schuell analytical paper No. 589. The ascending technique of Williams and Kirby (*6*) ~~was employed~~ for the *n*-butanol solvent and the descending technique (*1*) for the collidine solvent. Radioautographs[2] were prepared from the chromatograms in the conventional manner and the paper chromatograms were then developed with ninhydrin to demonstrate the presence of amino acids on the paper.

A diagram showing the radioactive substances in the hydrolyzate is shown in Fig. 1. Spots B and E correspond exactly with ninhydrin spots of 3,5-diiodotyrosine and thyroxine[3] respectively when these substances were added to a control paper. Radioiodide appears on the paper chromatogram as a double spot G and F and these were the sole spots observed with the purified solvents employed (Fig. 2). Spot C was routinely observed as a strong radioactive spot and corresponds in position to monoiodotyrosine as reported by Dent (*2*), the occurrence of which was also shown by Fink and Fink (*4*). Spot H has not been identified but corresponds in position approximately to diiodothyronine, as previously reported (*5*). Spots A and D are unknown iodine-containing substances which appear very faintly, but only A reacted with ninhydrin. Spot I has been consistently observed in all thyroid hydrolyzates and is also of unknown nature.

Fig. 3 shows a radioautograph prepared from a chromatogram of a thyroid hydrolyzate; the thyroid had been dialyzed exhaustively against cold water prior to hydrolysis. The presence of the characteristic iodide double spot indicates that free iodide is formed during alkaline hydrolysis or that the thyroid gland contains undialyzable iodide, possibly in bound form. Mono- and diiodotyrosine appear as strong spots, whereas thyroxine is relatively weak. The radioactive spot remaining at the origin is most likely a small residue of BaI_2, since in other similar studies careful removal of barium eliminated this spot and did not significantly alter the remainder of the chromatogram. Simple extraction of thyroid glands with collidine-lutidine revealed in the extracts the presence of radioactive spots corresponding to free iodide and mono- and diiodotyrosine, but no thyroxine was detected. This would indicate that mono- and diiodotyrosine exist in free form and are not completely bound to protein.

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[2] We are indebted to Mr. Robert Hay for the preparation of the radioautographs.

[3] We wish to thank Dr. D. P. Wallach for a generous sample of thyroxine isolated from iodinated casein.

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The Effects of Antagonists on the Multiplication of Vaccinia Virus *in Vitro*

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A large series of analogues og purine and pyrimidine bases and related substances (*6–9*) have been tested for their ability to interfere with the multiplication of vaccinia virus in tissue culture. The method described by Thompson (*11*) measures the multiplication of the virus in the presence and absence of added substances. The inhibitory effects of substituted amino acids (*11*) and of a phenylalanine analogue (*12*) have been reported.

In the general field of substances which might be expected to interfere with nucleic acid synthesis, many substances diminish the rate of multiplication of the virus virus during the incubation period, thus having an ap- and a few bring about a diminution in the titer of the parent virucidal activity.

In many instances the activities of the analogue on vaccinia virus bear a close resemblance to those on *Lactobacillus casei* (*6, 9*). Thus among the substances structurally related to thymine, 5-bromouracil, 5-nitrouracil, dithiothymine, and isobarbituric acid give small but significant and reproducible inhibitions (Table 1). Certain amides of aminouracil, such as 5-*p*-nitrobenzamidouracil, show similar activity. 2,6-Diaminopurine exhibits strong inhibitory effects, which are reversible by purines and nucleic acid derivatives (*13*).

TABLE 1

Influence of Pyrimidine Analogues on Multiplication of Vaccinia Virus

Compound	Conc. mg/ml	Increase in virus titer (logarithm 50% end point)	
		Control	Treated
5-Bromouracil	0.1	2.10	1.70
5-Nitrouracil	0.1	2.20	1.80
5-Hydroxyuracil	0.1	2.20	1.36
2,4-Dithiothymine	0.1	1.96	1.48
5-*p*-Nitrobenzamidouracil	0.1	2.30	1.67
2,6-Diaminopurine	0.05	1.30	−0.69
2,4-Diamino-5,6-dimethylpyrimidine	0.05	1.55	1.59
	0.1	1.55	1.14
4-Aminofolic acid	0.1	2.51	1.92

One outstanding difference between vaccinia virus and the bacterial and other growth systems lies in the failure of folic acid antagonists to show more than minimal inhibitions of the virus. This applies not only to the simpler bases, such as 2,4-diamino-5,6-dimethylpyrimidine, which exhibit antifolic activity in the bacterial systems (*8*), but also to the structural analogues of pteroylglutamic acid (PGA) such as 4-aminofolic acid, as shown in Table 1. The inhibitory effects of the structural analogues of PGA are evidenced in many biological systems which involve the rapid proliferation of cells (*2–4*). In general, diaminopurine has been found to have similar effects (*1, 5, 8*). However, a different locus of action of the two antagonists (*6*) is indicated by reversal studies (*6, 8*), and by the hematological findings (*10*). A possible explanation of the present studies might be that the proliferation of the virus occurs via a pathway which is blocked by diaminopurine but not by the folic acid analogues.

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[1] Parts of this program were carried out at Western Reserve University Medical School during 1945 and at the Medical College of Virginia 1946–7.

Book Reviews

Philosophy of mathematics and natural sciences. Hermann Weyl. Princeton, N. J.: Princeton Univ. Press, 1949. Pp. x + 311. $5.00.

Philosophers of science have long admired Weyl's "Philosophie der Mathematik und Naturwissenschaft," which appeared in Oldenbourg's *Handbuch der Philosophie* in 1927; they have also regretted its unavailability. The present volume is in part a translation of that classic work with its penetrating analysis of the philosophic foundations of arithmetic and geometry, and its clear formulation of the concepts of space, time, and relativity. The translation is ably done by Olaf Helmer and Joachim Weyl, the author's son. In addition, the book contains 80 pages of new material in the form of six appendices, the quality of which elevates this work to a unique rank in its field today.

With respect to subject matter, the appendices cover the most important topics of scientific methodology (the effects of Gödel's theorems on the structure of mathematics, quantum physics and causality, physics and biology). Their attractiveness is greatly increased, however, by the author's philosophic frankness, by his clear statements of the motives for his selection. Up to 1926, the continuous, extensive medium of space and time stood in the center of philosophic thought. Meanwhile, the discontinuous combinatorial structures of quantum theory, its concern for symmetries, have become increasingly significant. In view of this change, the new portions of the book attack "ars combinatoria" on a very basic plane and show its relation to several of the theories of modern physics. A new point of view is brought to bear upon the problem of chemical valence, and the only regret one might feel in reading Appendix D, which deals with it, is that the elegant treatment is so condensed as to leave it beyond the grasp of many workers in the field.

HENRY MARGENAU

Yale University

History of the primates: An introduction to the study of fossil man. W. E. Le Gros Clark. London: British Museum (Natural History), 1949. Pp. 117. (Illustrated.) 2s 6d.

That well-served character, the intelligent layman, will find here an answer to almost any reasonable question on present knowledge of the ancestry of man. The discussion is scientific in the best sense but is thoroughly readable and nontechnical. From the general principles of evolution and of classification through the fossil and recent lower primates to fossil man and the rise of *Homo sapiens*, the treatment is amazingly complete for so short a book, phrased in such easily comprehensible terms. Its excellent balance, its cautious and fair presentation of controversial points, and its inclusion of the most recent discoveries and studies make this surely among the best and perhaps quite the best available work on the subject for the layman.

The more professionally interested reader will be specially concerned with Professor Le Gros Clark's comments on the crucial and disputed episodes in human phylogeny. Although no one has better right to opinions on this subject, he presents the issues fairly and without ex-cathedra edicts, but he does quite properly weigh the probabilities.

The higher primates are suggested to have arisen from some of the more advanced Eocene tarsioids, rather than from lemuroids or less clearly differentiated prosimians. The hominoid group (including both apes and men) is believed to have had an independent origin among the tarsioids and not to have passed through a cercopithecoid stage. All the hominoids are indicated as having a common, ultimately monophyletic origin among unspecialized, mid-Tertiary apes from which arose the specialized recent apes, on one hand, and the hominids, on the other. Evidence for this degree of affinity of apes and men is seen among the generally primitive Miocene apes, still typified by *Dryopithecus*, although the group is now known to have been rather highly diverse and to have included, for instance, such forms as the somewhat chimpanzee-like *Proconsul*.

The South African Australopithecinae are stressed. The vexatious question of their generic and specific classification is evaded, and their essential common characters are described and illustrated without specification as to the several supposedly distinct types. The australopithecines as a group are regarded as closely related to man, either as direct ancestors or as little-modified survivors of an ancestral stock.

Pithecanthropus (including *Sinanthropus* as a synonym) is also considered directly ancestral to later hominids. It is suggested that descent from *Pithecanthropus* occurred in two different lines, one leading to the neandertaloids as a distinct, specialized offshoot that became totally extinct, and the other leading through such forms as the Swanscombe, Steinheim, and Ehringsdorf men to modern man, *Homo sapiens* strictly speaking.

Each of these phylogenetic decisions invites discussion and all will be disputed by one student or another. This is not the place to argue them, and the author continually emphasizes that they are matters of opinion in a field where too many of the facts still elude us.

The book contains no restorations of prehistoric men or other fossil primates and is not provided with a graphic phylogenetic tree. Most of the illustrations are factual drawings of living animals or of known fossil remains. The farthest departure from this objectivity is a diagram of the questionable Milankovitch-Zeuner chronology of the Pleistocene, and the provisional nature of this is duly noted.

This is a well-written, sound, modest book for which we should be duly thankful. Wide distribution in the United States of this or of a comparably inexpensive American edition would be highly desirable.

GEORGE GAYLORD SIMPSON

American Museum of Natural History

Elmtown's youth: The impact of social classes on adolescents. August B. Hollingshead. New York: John Wiley; London: Chapman & Hall, 1949. Pp. x + 480. $5.00.

Social class in America: A manual for the measurement of social status. W. Lloyd Warner, Marchia Meeker, and Kenneth Eells. Chicago: Science Research Associates, 1949. Pp. xiii + 274. $4.25.

These two books, both written by sociologists, describe the social classes in a Midwestern town which is called Elmtown in one book and Jonesville in the other.

Elmtown's youth is "an analysis of the way the social system organizes and controls the social behavior of high-school-aged adolescents reared in it." The purpose of *Social class in America* is not the description of the town as such, but rather, the exposition of methods of analyzing social classes, with illustrative material drawn from this town.

Considered together, the two volumes detract from each other. Two sets of pseudonyms are used; yet the characters are recognizable from one book to the other, since the leading citizens and informers are naturally the same for both. Incidents are somewhat disguised to protect the identity of the inhabitants, and these disguises also vary, giving a feeling of unreality to the same events in this very real community.

Considered separately, the volumes represent two important contributions in the study of community life in America.

In *Elmtown*, Dr. Hollingshead found 735 adolescents of high school age in a community of some 10,000 people. The community tended to ignore the 345 adolescents who were not in school. In general, the children remaining in high school belonged to the families in better and more stable economic position.

Many fascinating details are given of the methods used to teach children "acceptable and unacceptable behavior relative to the family, the job, property, money, the school, the government, men, women, sex, and recreation. It is perfectly normal for families in the same or an adjacent [social] class, concentrated in a particular residential area, . . . to provide their children with significantly different learning situations from those of families in other classes who live in other residential areas."

The analysis of the process by which the young unskilled worker adjusts to the demands of the working world is particularly interesting. The adolescent takes a job to secure "freedom" (from school and from dependence on his parents). The jobs "are mean, dirty, undesirable, and generally seasonal or temporary." These factors "produce discontent and frustration, which motivate the young worker to seek another job, only to realize after a few weeks that the new job is like the old one." The average boy holds five jobs in his first year to a year and a half out of school. Afterwards, he becomes a more stable worker at a slightly higher rate of pay.

In *Social class in America*, Dr. Warner and his coauthors give two measures for analyzing social class. The crux of "Evaluated Participation" is persuading a community to judge each other's social class. "The Index of Status Characteristics" consists essentially of the sociologist rating the individual by judging his position in the social hierarchy in regard to occupation, source of income, house type, and dwelling area. These facts can ordinarily be secured easily.

The book is probably not the final one in the series written by Warner and collaborators. In the reviewer's opinion, there will be still further refinements of these measures. The present exposition will convince most readers, however, of the reality of social class; and will teach something about the methods of studying a community.

My own reaction to the scales of social class is that the values used for them are those of the small-town banker. Most scientists at one time or another must meet the inspection of the banker. But in addition, scientists class each other's prestige on a scale having little in common with the banker's.

A class structure for university scientists might be constructed along the following lines:

Upper-Upper.	Has the highest originality; constructs theories which other scientists test for years to come.
Lower-Upper.	Spends all possible time on research. Constructs theories dealing with limited areas. Envies the originality of the Upper-Upper.
Upper-Middle.	Is a revered teacher of younger scientists. Can verbalize the theories proposed by two upper classes adequately. Publishes an occasional research paper.
Lower-Middle.	Teaches other scientists, but has no reputation. Has published nothing but his doctoral dissertation.
Upper-Lower.	Teaches a scientific subject in a routine manner to students who are not enthusiastic. Turns in grades promptly at the end of the term.
Lower-Lower.	Fails to meet his classes. His students complain to the administration about him. His knowledge is limited; he takes to telling jokes unrelated to his subject.

A farming community such as Jonesville (Elmstown) places at the top people who have been prosperously living there for some generations. A group of scientists might place at the top an individual who has been rapidly promoted from one institution to another, with consequent impoverishment of his bank account, and with the additional factor that his neighbors in a physical sense might not know him. Sociologists will have to take account of the fact that the human being is complicated enough to strive in more than one type of prestige structure.

HELEN M. WOLFLE

American Psychological Association

NEWS and Notes

Paul P. Ewald, professor of mathematical physics at Queen's University, Belfast, has arrived here to become chairman of the Department of Physics at the Polytechnic Institute of Brooklyn. Dr. Ewald, who is the editor of *Acta Crystallographica*, plans to return to experimental work in the physics of the solid state.

Robert S. Hotchkiss, formerly at Cornell University Medical College, has been appointed professor and chairman of the Department of Urology, New York University Post-Graduate Medical School, a unit of the New York University-Bellevue Medical Center. Dr. Hotchkiss will be in charge of all urological research, teaching, and patient care at the Medical Center.

Sergio De Benedetti, professor of physics at Washington University, St. Louis, has joined the staff of the Physics Department at Carnegie Institute of Technology, Pittsburgh. Dr. De Benedetti was associated with the Curie Laboratory in Paris during the war.

Linus Pauling, president of the American Chemical Society, and director of the Department of Chemistry, California Institute of Technology, will deliver the second bicentennial science lecture of the City College Chemistry Alumni Association on December 7 at City College, New York. Dr. Pauling will talk on "Structural Chemistry in Relation to Biology and Medicine."

Wallace Waterfall, formerly director of research and product development for the Celotex Corporation, has been appointed to the newly created position of executive secretary of the American Institute of Physics. Mr. Waterfall has been a member of the AIP Governing Board since 1934 and its secretary since 1945.

I. C. Gunsalus, professor of bacteriology, Indiana University, will deliver the second Harvey Lecture of the current series at the New York Academy of Medicine on November 17. Dr. Gunsalus will speak on "Comparative Metabolism: Bacterial Nutrition and Metabolic Function."

Visitors to U. S.

J. F. Toennies, neurophysiologist, formerly with the Rockefeller Institute in New York, and now engaged in electronic developments in Freiburg, Germany, is visiting various institutions in this country. He may be reached at the Institute for Cancer Research, Fox Chase, Philadelphia 11, Pennsylvania until December 10, when he returns to Freiburg.

The University of Cincinnati section of Sigma Xi presented **Raymond A. Dart**, of the University of Witwatersrand, Johannesburg, as its first lecturer of the academic year, on October 28. Dr. Dart is visiting a number of university centers, under the sponsorship of the Rockefeller Foundation. In addition to the Cincinnati lecture he has presented a series of Lowell lectures at Cambridge, as well as others in this country and Canada. Dr. Dart, discoverer of *Australopithecus*, lectured on "The Fossil Man-Apes from South Africa," illustrating his lecture with slides, casts, and fossils from his work at Taungs and Makapan.

Visitors at the National Bureau of Standards during the week of October 3–7 included: **George Campbell** of the Plessney Company, Ilford, Essex, England; **G. Herzberg**, chief, Division of Physics, National Research Council, Ottawa; **G. David Scott**, assistant professor of physics, University of Toronto, Canada; **A. Strasheim**, senior scientific officer, National Physical Laboratory, Pretoria, South African Union; **Richard Wieweg**, professor, Technischen Hochschule, Darmstadt, Germany; **F. C. Williams**, professor of mathematics, University of Manchester, England; and **R. W. Callon**, chief spectroscopist, Aluminum Laboratories, Ltd., Quebec.

Martin Gusinde, of Vienna, has been appointed visiting professor of ethnology at the Catholic University of America. Dr. Gusinde is giving graduate courses in general ethnology, and on the Indians of South America and the Pygmies of Africa and Asia.

Fritz Strauss, prosector in the Anatomical Institute of the University of Bern, is doing research on problems of mammalian reproduction at the Department of Anatomy of the University of Wisconsin. He plans to be there most of the 1949–50 academic year.

A. Smekal, professor of physical chemistry, University of Darmstadt, Germany, **Eric K. Rideal**, director of the Royal Institution of London, and **W. G. Burgers**, professor of physical chemistry at the Polytechnic Institute, Delft, Holland, were speakers at the Conference on the Solid State at the Polytechnic Institute of Brooklyn, New York, on October 15.

Grants and Awards

The Nobel Peace Prize for 1949 has been awarded to Lord Boyd Orr, Scottish physiologist and former director general of the United Nations Food and Agriculture Organization. Lord Boyd Orr was president of the Congress of World Federalists, held recently in Stockholm, and he plans to use the prize (this year it amounts to about $21,000) to further the world federalist movement.

Rutgers University has announced the award to faculty members of 62 research grants totaling $85,560 from the University Research Fund. The grants are for the year ending June 30, 1950. Thirteen grants, totaling $14,710, were made in the field of biological sciences. Sixteen grants, totaling $24,885, were in mathematics and the physical sciences. Four, for a total of $13,490, were made to support research projects in engineering. The other 29 grants were designated for the humanities and social sciences.

The Acoustics Laboratory of the Massachusetts Institute of Technology has announced the following fellowship grants in architectural acoustics for the academic year 1949–50: the Armstrong Cork Company Fellowship to Jordan J. Baruch, of Brooklyn, New York; the Acoustical Materials Association Fellowship to Uno Ingard, of Gothenburg, Sweden.

Fellowships

The Harry Bateman Research Fellowships in pure mathematics are being offered for 1950–51 at the California Institute of Technology. Fellows must hold a Ph.D. degree and will devote the major portion of their time to research. In addition, they are expected to teach one advanced course in mathematics. The stipend is $3,600 for the academic year. For application blanks and further information, address the Dean of the Faculty, California Institute of Technology, Pasadena 4, California. Applications must be returned before *February 15, 1950.*

At the request of the **Office of Naval Research,** the National Research Council has appointed an advisory committee of astronomers to recommend specific research projects in astronomy and astrophysics for support by ONR. The committee has suggested that the average cost per project should be about $3,000, with a maximum of $5,000. When a proposal is selected for support by ONR, negotiations will be entered into for a contract between the U. S. Navy and the institution at which the research will be conducted. Applications for the support of projects to be considered this winter should be received at the ONR on or before *December 15.* Full information may be obtained from the Chief of Naval Research, Washington 25, D. C., Attention: Code 432.

The Educational Testing Service is offering two research fellowships in psychometrics for 1950–51,. leading to the Ph.D. degree at Princeton University. Each carries a stipend of $2,375 a year and is renewable. Fellows will be engaged in part-time research in the general area of psychological measurement at the offices of the Educational Testing Service and will carry a normal program in the Graduate School. Information and application blanks may be obtained from the Director of the Psychometric Fellowship Program, Educational Testing Service, Box 592, Princeton, New Jersey.

Colleges and Universities

The University of Washington's $1,050,000 School of Fisheries Building, located on Portage Bay, will be occupied by the school and its associated laboratories soon after January 1, 1950. The new building will house complete facilities for biological research, including the measurement of the effects of radiation on aquatic organisms being carried on under the direction of Lauren R. Donaldson, in conjunction with the Atomic Energy Commission.

The University of Pittsburgh School of Medicine has opened its new Addison H. Gibson Laboratory, established by a grant from the Addison H. Gibson Foundation, to provide additional facilities for studies in applied physiology. The laboratory will investigate problems of arteriosclerosis and provide service facilities for the handling of radioactive isotopes. Campbell Moses has been appointed director.

Meetings and Elections

Stanford University School of Medicine will present its 30th course of Lane Medical Lectures, October 31–November 10 at 8:15 p.m. in Lane Hall, 2398 Sacramento Street, San Francisco. The lectures will be delivered by James L. Gamble, professor of pediatrics and chairman of the Department of Pediatrics, Harvard Medical School, on various phases of the companionship of water and electrolytes in the organization of body fluids.

The American Petroleum Institute will hold its 29th annual meeting in Chicago, November 7–10. Two general sessions will be held on the afternoon and evening of November 9. On November 10 the Division of Refining will hold a group session on "Fuels of the Future." Papers will be presented at this session by William M. Holaday, of Socony-Vacuum Oil Company, Inc., and by Walter G. Whitman, of Massachusetts Institute of Technology.

The American Society of Mechanical Engineers will hold its 70th annual meeting at the Statler Hotel, New York City, November 28–December 2. Seventy-eight technical sessions will be sponsored by 22 professional divisions and committees of ASME, covering the fields of power, aviation, applied mechanics, fuels, gas turbines, heat transfer, hydraulics, industrial instruments and regulators, machine design, management, materials handling, metals engineering, oil and gas power, process industries, production engineering, railroad, rubber and plastics, textiles, wood industries, and petroleum.

Among the speakers at the meeting will be H. J. Gough, president of the Institution of Mechanical Engineers of Great Britain, Lillian M. Gilbreth, outstanding women engineer, F. C. Hottel, of the Massachusetts Institute of Technology, Paul C. Aebersold, chief of the Isotopes Division, Oak Ridge, Tennessee, and Hugh L. Dryden, director of aeronautical research for the National Advisory Committee for Aeronautics.

A national conference on cardiovascular diseases will be held in Washington, D. C., January 18–20, under the joint sponsorship of the American Heart Association and the National Heart Institute of the U. S. Public Health Service. H. M. Marvin, president of the American Heart Association, and C. J. Van Slyke, director of the National Heart Institute, will be cochairmen of the conference, which will bring together physicians, scientists, community service leaders, and members of allied professions to formulate a comprehensive heart disease control program.

The American Meteorological Society's 30th anniversary meeting in St. Louis, January 3–6, 1950, will feature an air pollution symposium. One part of the symposium will be a panel discussion on the different phases of air pollution abatement. This discussion will be open to scientists, technicians, and the public and, following a brief description of each panel member's special subject, their comments and questions from the floor will be invited. The second part will be a series of technical papers, selected to emphasize the meteorological and climatological phases of air pollution, including urban diffusion of smokes, forecasting atmospheric dispersion conditions, dispersion from stacks, and climate influences on pollution.

Chairman of the symposium is C. A. Gosline, of the E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware.

The Southern Association of Science and Industry will hold its winter meeting January 23–24 at the Hotel Roosevelt, in New Orleans. Paul W. Chapman, dean of the University of Georgia, has been named general program chairman, and James N. Gowanloch, chief biologist of the Wildlife and Fisheries Department, of New Orleans, will be chairman of the committee on local arrangements. There will be three discussion sessions on the use of research in increasing farm production efficiency, preserving and transporting farm products, and finding industrial uses for these products.

The American Association of the History of Medicine will hold its 1950 annual meeting in Boston May 21–23. Members of the association who wish to submit papers should communicate with the chairman of the program committee, Dr. Harold Bowditch, 44 Harvard Avenue, Brookline, Massachusetts. Papers must be submitted before *January 15*.

The Worcester Foundation for Experimental Biology has elected the following trustees for a term of four years: Charles B. Huggins, professor of surgery at the University of Chicago; Rear Admiral George W. Calver, U.S.N. (M.C.); and Ralph F. Gow, executive vice president of the Norton Company.

The Institut Internationale d'Embryologie, an elective body of 75 members, affiliated with Unesco, elected the following officers at a recent meeting in Bern, Switzerland: president, M. W. Woerdeman, Holland; vice presidents, E. Fauré-Fremiet, France; F. E. Lehmann, Switzerland; Paul Weiss, U. S.; executive committee members, G. R. de Beer, Great Britain, and A. Dalcq, Belgium; and secretary-treasurer, C. P. Raven, Holland.

The Coordinating Committee on Abstracting and Indexing of Medical and Biological Sciences met in Paris, at Unesco House, June 1–4, under the sponsorship of the Natural Sciences Section of Unesco and the World Health Organization. The meeting was efficiently organized by I. M. Zhukova, head of Applied Sciences, Unesco. Hugh Clegg, Editor of the *British Medical Journal*, served as chairman, and M. W. Woerdeman, editor-in-chief of *Excerpta Medica* and Eileen R. Cunningham, Vanderbilt University School of Medicine, served as vice chairmen. The meeting was opened by addresses from Director-General J. Torres Bodet; P. Auger, director of the Division of Natural Sciences; N. Howard-Jones, director of library and reference services, WHO; and F. Verzar, who spoke from the point of view of the Food and Agriculture Organization.

Several important decisions were made during the meeting. First, the members felt that the usefulness of the committee which, up to now, has been functioning on an interim basis, had been fully demonstrated. After an appraisal of past activities and a discussion of future plans for work the members voted unanimously to continue on a permanent basis under their present relationship to Unesco. Second, while the committee recognized that adequate indexing of medical literature presents certain problems not comparable to those of abstracting, it was felt that these two methods of making information concerning current literature available to scientists are, in many ways, so closely related that the scope of the committee's activities should be enlarged to include indexing as well.

Papers given during the meeting presented the views of the users of abstract services, as well as problems involved in the production of abstracts. Much evidence was presented indicating the desirability of having the bibliographic detail of the entry as complete as possible. and of having the author's name come first in the bibliographic entry. Both information gathered from users of abstracts, and the expressed views of the members of the committee coincided in advocating the standardization of the bibliographic form used in the various abstracting services.

Standardization of abbreviations, avoidance of local abbreviations, and adoption of the metric system in all medical and biological communications was endorsed by the committee, which also recommended that editors of medical and biological journals adopt greater uniformity in terms and greater precision in the papers appearing in their journals.

Professor Woerdeman and Mrs. Cunningham were appointed as the committee's representatives to the International Conference on Scientific Abstracting, held in Paris, June 20–25, following the meeting of the Coordinating Committee on Abstracting and Indexing of Medical and Biological Sciences (See *Science*, July 29, page 132). Mrs. Cunningham presented a report of the committee's activities, which was discussed during one of the plenary sessions of the conference.

The official U. S. delegation to the international conference consisted of three voting delegates: Verner W. Clapp, of the Library of Congress, who served as chairman of the delegation and one of the vice presidents of the conference; Evan Crane, editor of *Chemical Abstracts*; J. Murray Luck, editor of *Annual Reviews*, and three technical advisers: Mrs. Cunningham, chairman, Medical Library Association's Committee on Abstracting; John E. Flynn, editor of *Biological Abstracts*, and Eugene W. Scott, Interdepartment Committee on Research and Development. Also present as consultants and observers were Norman T. Ball, Technical Information, Research and Development Board; John E. Burchard, Massachusetts Institute of Technology; Dwight E. Gray, American Institute of Physics; Sanford V. Larkey, Johns Hopkins University, Welch Medical Library; and R. H. Phelps, Engineering Society Library.

The conference voted to establish a provisional international advisory committee to work with Unesco on abstracting for one year, pending the formation of a permanent committee. Appointments to this committee were reported in *Science*, October 7.

EILEEN R. CUNNINGHAM

Deaths

Filippo Silvestri, 76, entomologist, died at Bevagna, Italy, June 10. Dr. Silvestri specialized in the Thysanura, Entotrophi, and Isoptera. He was for many years the director of the Laboratory of Entomology of the Portici branch of the University of Naples, and had retired in 1948. He was a Fellow of the Entomological Society of America.

William Henry Watters, 73, pathologist, died October 10 in Hyannis, Massachusetts. Dr. Watters was at one time professor of pathology at Boston University and for many years had been an associate in the legal department of the Harvard University Medical School.

Robert Tilden Frank, 74, gynecologist, died October 15 in New York City, following a brief illness. Dr. Frank has been associated with Mount Sinai Hospital since 1906. In 1925 he founded its Endocrine Research Laboratory and remained at its head until 1944.

The dedicatory exercises and formal opening of the new laboratories of the **Institute for Cancer Research** and the **Lankenau Hospital Research Institute** in Fox Chase, Philadelphia, are to be held November 15–16. The first day will be devoted to the formal opening exercises, at which Charles F. Kettering will be the principal speaker. On the second day, the subject "Modes of Procedure in Cancer Research" will be discussed by C. C. Little, R. G. Meader, and C. F. Huggins. On both days, open house and demonstrations will be held by the staff.

An inaugural series of scientific programs is being planned for the spring of 1950 and will be announced later.

A limited number of travel allotments to the **Fifth International Cancer Congress** to be held in Paris, July 17–22, 1950, will be available to scientists requiring such assistance. The recipients of the travel allotments will be selected by the several agencies, foundations, or societies that support cancer research and that are contributing the funds. Applications should be submitted in letter form, giving information concerning age, training, publications in cancer or related fields, present academic or professional status, a brief abstract of major current investigative work, and statement of work to be presented at the congress. A letter from the laboratory director or administrative officer approving the application is also necessary. Send applications to W. U. Gardner, Member of Congress Committee, 333 Cedar Street, New Haven, Connecticut before *November 16.*

A Society for Social Responsibility in Science has been formed by a group of scientists and engineers who met at Haverford College, Pennsylvania, on September 15.

The constitution states the aims of the society to be: ". . . to foster throughout the world a . . . tradition of personal moral responsibility for the consequences for humanity of professional activity, with emphasis on constructive alternatives to militarism; to embody in this tradition the principle that the individual must abstain from destructive work and devote himself to constructive work, according to his own moral judgment; to ascertain . . . the boundary between constructive and destructive work, to serve as a guide for individual and group decisions and action; to establish and operate an employment service . . . for those individuals whose convictions necessitate leaving or refusing destructive work; to assist those individuals who suffer economic or legal difficulties because of . . . abstaining from . . . destructive activity."

The first officers are: president, Victor Paschkis, director of an engineering research laboratory of Columbia University; vice president, William F. Hewitt, Jr., physiologist at Howard University School of Medicine; secretary-treasurer, Vincent Cochrane, biologist at Wesleyan University. Elected to the council of the SSRS were Leonard Dart, physicist for American Viscose Corporation, Marcus Hook, Pennsylvania; Theodore B. Hetzel, of the engineering faculty at Haverford College; Franklin Miller, Jr., physicist at Kenyon College, Gambier, Ohio; William T. Scott, physicist at Brookhaven National Laboratory and at Smith College; and James G. Vail, past president of the American Institute of Chemical Engineers.

The society will work on a unanimous basis, rather than by parliamentary procedures. Regional and functional groups of the SSRS are to be organized soon. English, German, and Swiss scientists have expressed interest in the organization. For further information write Victor Paschkis, Hidden Springs, R.D., Neshanic Station, New Jersey.

Recently Received—

The Mapleton Meteorite. Sharat Kumar Roy and Robert Kriss Wyant. Geological Series of Field Museum of Natural History, Chicago. Vol. VII, No. 7. 40¢.

The Vitamin Content of Peas as Influenced by Maturity, Fertilizers, and Variety. Ethelwyn B. Wilcox and Katharine E. Morrell. Agric. Exp. Sta., Bull. 337, Utah State Agricultural College.

Annual Report of the Director of the Department of Terrestrial Magnetism, 1947–48. Merle A. Tuve. Reprint, Carnegie Institution of Washington Year Book No. 47.

Characteristics of Residual Insecticides Toxic to the House Fly. Willis N. Bruce. Illinois Natural History Survey Bull., Vol. 25, Art. 1. State of Illinois Department of Registration and Education, Urbana.

The Spectrum of Nova Persei 1901. Dean B. McLaughlin. Publ. University of Michigan Observatory, Vol. IX, No. 3.

Psychology and Scientific Research.
I. The Nature of Scientific Inquiry

Hadley Cantril, Adelbert Ames, Jr., Albert H. Hastorf, and William H. Ittelson

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> The traditional code of science—that is, the objectives sought and the methods of investigation—cannot satisfy the requirements of our critical times, and this is why science has failed to measure up to the opportunities and obligations before it. The generally accepted ideas of what natural science is and what it is for are out of date and need radical revision.—C. J. Herrick (*8*, V)

A FEELING OF URGENCY for a more adequate understanding of man and his social relations can be sensed in today's intellectual atmosphere. People are becoming more and more anxious about the ability of psychologists and social scientists to help solve the problems arising from our technological advances and from the swift social transitions they leave in their wake. But unfortunately what Herrick has said about the natural sciences applies especially to those sciences which deal with man—psychology and the social sciences in general. Moreover, in these sciences, in contrast to the physical sciences, there seems to be less agreement as to what constitutes significant research.

Obviously, an increase in our understanding of man can come about only as we extend our empirical knowledge and improve our formulations through research of demonstrated significance. And before that is possible, we must increase our understanding of the scientific process through which discoveries are made. But sometimes the scientist's interest in building up the content of his discipline sidetracks him from a consideration of the scientific process itself and creates a lag in the understanding and improvement of scientific tools. What follows is an attempt to clarify our thinking about the nature of scientific research in those fields which take upon themselves the primary responsibility of accounting for man's thoughts and behavior. Only then will such research accomplish what we have a right to expect of it.

We shall first consider the nature of scientific inquiry, trying to find out why man pursues scientific inquiry, anyway—what function it serves him, and what steps seem to be involved. We shall then distinguish between scientific inquiry and scientific method—a distinction which seems necessary to avoid certain pitfalls and to assure scientific progress. Then we shall try to point out some of the specific implications to be derived for psychology from a better understanding of the nature of scientific inquiry and the role of scientific method and we shall indicate to what degree science can be "objective." Finally, some suggestions will be made which might accelerate the kind of scientific research that will increase our understanding of man.

The apparent reason for scientific inquiry is essentially the reason for any inquiry—to solve a problem. Scientific inquiry can never be understood if it is somehow put on a pedestal and viewed as something remote and apart from man's everyday activities. "Science," says Conant, "emerges from the other progressive activities of man to the extent that new concepts arise from experiments and observations" (*1*, 24).

These activities of life are carried through in an environment which includes people, artifacts, the phenomena of nature. Man's only contact with this environment is through his senses. And the impressions man's senses give him are cryptograms in the sense that they have no meaning unless and until they become functionally related to man's purposive activities. The world man creates for himself through what Einstein has called the "rabble of the senses" is one that takes on a degree of order, system, and meaning as man builds up through tested experience a pattern of assumptions and expectancies on which he can base action.

Man builds up his assumptive or form world largely in an unconscious and nonintellectual way, in the process of adjustment and development as he goes about the business of life, that is, as he tries to act effectively to achieve his purposes. Man often uses many of his assumptions without being at all aware of them, such as those involved in reflex activity, habits, stereotypes, and a whole host of perceptual activities. Man is aware of other assumptions from time to time as they become relevant to the situation at hand, such as loyalties, expectancies, ideals. Still others, such as intellectual abstractions, can be brought to voluntary recall. Man's actions cannot be effective unless and until he builds up an assumptive or form world that has some degree of constancy and verifiability.[1]

What man brings to any concrete event is, then, an accumulation of assumptions, of awarenesses, and of knowledge concerning the relatively determined aspects of his environment as derived from his past experiences. But since the environment through which man carries out his life transactions is constantly changing, any person is constantly running into hitches and trying to do away with them. The assumptive world a person brings to the "now" of a concrete situation cannot disclose to him the undetermined significances continually emerging. And so we run into hitches in everyday life because of our *inadequate understanding of the conditions giving rise* to a phenomenon, and our ability to act effectively for a purpose becomes inadequate.

When we try to grasp this inadequacy intellectually and get at the why of the ineffectiveness of our purposeful action, we are adopting the attitude of scientific inquiry. Man as scientist tries to understand what aspect of his environment is responsible for a hitch and then calls upon what knowledge he has that is relevant to an understanding of the determined, predictable nature of the particular phenomenon in question. Modern man uses the scientific method as a tool because he has found empirically that he can increase his understanding and act more effectively if his pursuits are guided by some knowledge concerning the determined aspects of the phenomenal world. G. H. Mead pointed out (*9*, 41) that

> . . . Every discovery as such begins with experiences which have to be stated in terms of the biography of the discoverer. The man can note exceptions and implications which other people do not see and can only record them in terms of his own experience. He puts them in that form in order that other persons may get a like experience, and then he undertakes to find out what the *explanation of these strange facts is.*

Since the scientist's acquired purpose is to increase his understanding of a certain range of phenomena, when he experiences a hitch in his understanding of such phenomena he tries to bring to conscious awareness the reason for the hitch, that is, he tries to formulate intellectual concepts that will explain away the hitch. He does this by examining the probable conditional relationships except for which he, as an experiencing individual in a concrete situation, would not be faced with the hitch. He abstracts out of the hitch-situation those aspects he believes are probably necessary to his understanding of the original hitch. In his inquiry, the scientist arbitrarily treats these abstracted aspects of a phenomenon as if they existed in their own right. He does not do this simply because he wants to but because he has to, in order to recall and manipulate the phenomenon intellectually. The abstractions man is able to form have on him what Dewey and Bentley characterize as a tremendous "liberative effect," making possible the voluntary, controlled conceptual thinking necessary for scientific inquiry and for the use of scientific method.

From this point of view, we might say in general that science is an activity designed by man to increase the reliability and verifiability of his assumptive world. For it would appear that in the last analysis any scientific pursuit—no matter how abstruse it seems—is carried on because it is somehow of concern to man. Science is the human effort to understand more about nature and human nature in verifiable, determined terms. The word *determined* is used here in the scientific sense as meaning high in prognostic reliability. From this it is clear that real progress in any science involves an awareness of our assumptive worlds, a consciousness of their inadequacy, and a constant, self-conscious attempt to change them so that the intellectual abstractions they contain will achieve increasing breadth and usefulness. Real progress in science means much more than merely adding to existing knowledge.

The processes involved in scientific inquiry would seem to be somewhat as follows: (1) sensing the inadequacy of the conceptual aspects of our assumptive world, thereby being faced with a problem for which we must seek an answer; (2) deciding on all those aspects of a phenomenon that might have a significant bearing on the problem: deciding on those aspects except for which the functional activities in question would not exist; (3) picking out from the various aspects assumed to be involved those that seem most important in terms of the original hitch we faced and that will serve as bases for standards we can think about and manipulate; (4) working out some method of changing those aspects we have chosen as variables or bases for standards and conducting our empirical investigations accordingly; (5) modifying our assumptive world on the basis of the empirical evidence concerning the validity of formulations that have resolved an immediate problem.

The solving of the immediate problem will automatically give rise to new hitches and the above process constantly repeats itself.[2]

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[1] The nature and function of man's assumptive or form world is much too large a subject to treat in any detail here and must be reserved for later consideration.

[2] There seems to be a striking similarity between the processes used in scientific inquiry and the processes man makes use of in building up the assumptive world. Both science and common sense can be regarded as functional activities man uses in carrying out his life transactions. And the

Specifically, it seems that scientific inquiry has two major functions for man. First, it provides man with a bundle of what are called "scientific facts." This bundle is composed of his up-to-the-now understandings of the determined, predictable aspects of nature and is used by him for purposes of prediction and control. There are essentially two varieties of these scientific facts: general statements of relationships of determined aspects of nature which we refer to as "scientific laws" and which, in the physical sciences, tend to be expressed in mathematical formulas; second, applications of these general laws to concrete situations for purposes of verification, specific prediction, or control. The characteristic of all these generalized scientific laws is that they disclose predictable aspects of types of phenomena no matter where or when they occur, irrespective of actual concrete situations.

A second function of science is that it provides a conceptual reorganization of the knowledge man has already acquired of the determined aspects of nature. Here we are trying to increase our range of understanding, or, as Dewey and Bentley phrase it, to improve our "specification," that is, our accuracy in naming (*4, 5*). Here, for example, the specifications involved in relativity are more accurate namings of phenomena than are Newton's concepts, and in this sense, Newton's concepts are not to be regarded as "wrong." This function of science includes that of increasing the range of man's conceptual knowledge through the discovery of more and more predictable aspects of nature that up to the present time remain undetermined.

Understanding and prediction. The aim of science is often defined as the attempt to increase the accuracy of our predictions. While the accuracy of predictions is clearly a most important criterion of progress in scientific formulation, emphasis on prediction alone can easily obscure the more fundamental aim of science covered by the word ***understanding***. When we use the word understanding we are giving emphasis to the importance of increasing the range of our conceptual knowledge. Increased accuracy of prediction will be an inevitable coproduct of increased understanding in this sense. Any increase in understanding is also inevitably accompanied, sooner or later, by an increased ability to control variables and to apply our knowledge. Understanding also avoids the implication of a rigid determinism which seems, among other things, to be inconsistent with the fundamental indeterminism of modern physics.

Every scientific investigator must bear in mind that it is impossible for scientific research to disclose the unique specificity involved in any one actual occasion—e.g., the student of modern physics knows that there is no law governing the behavior of an individual atom. And the investigator must also remember that it is impossible to predict with any complete accuracy the specific nature of growth and emergence, which are themselves undetermined. While it is impossible to determine the undetermined nature of emergence, it is still possible to increase our scientific knowledge about emergence through understanding more about the relatively determined phenomena immediately related to these undetermined emergent aspects. For example, we may hope to understand more about the extent of the undetermined field; to understand more about the conditions which make it possible for the undetermined aspects to emerge. In other words, our understanding of emergence can improve only insofar as we become more and more aware of the boundaries of our determined world.

It is here that many of those who equate science with prediction or who use a narrow working definition of operationism are also those who will say they want nothing to do with the speculations of philosophy. And yet it is only by taking the philosopher's point of view, by bringing in freely all factors that might conceivably be involved in a single situation, that we can become aware of the boundaries of our up-to-the-now, determined scientific world. In discussing the role of philosophy, Conant writes that "there must be constant critical appraisal of the progress of science and in particular of scientific concepts and operation" (*1*, 13 f.). In their book on ***The evolution of physics,*** Einstein and Infeld repeatedly emphasize the new philosophic views which have both helped to evolve and have evolved from physical research. Any scientific investigator who pushes his

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method of scientific inquiry seems in many ways to be an unconscious imitation of those age-old processes man has employed in his common-sense solutions of problems. In common-sense activity, the assumptions and awarenesses on which man depends for effective action are the hypotheses he has built up from his many experiences: weighted averages he unconsciously uses to give him a high prognosis for effective action.

There are, however, certain important differences between the steps involved in pursuing scientific inquiry and the apparent processes that constitute common sense. A most important difference is the fact that in using scientific inquiry, man is the operator who decides what he is going to operate on and how. In an everyday life situation, however, man is not only the operator but he is also being operated on and must carry out his activities in the midst of the situation itself. When we meet hitches in everyday life and try to overcome them with hunches for effective action, we test these hunches by the action itself in a more or less insightful, more or less conscious way. In scientific inquiry, on the other hand, hunches are tested by controlled experiments and a deliberate attempt is made to intellectualize the processes involved (cf. *3*).

field of inquiry beyond the realm of the determinable and the repeatable out into the no man's land of emergence will inevitably become entangled with metaphysical problems. In so doing, he can hope that what is metaphysical for him today can tomorrow be part of the understood, physically determined, repeatable, and verifiable.

Transactional observation. Our own philosophical basis for our thinking concerning the nature and function of scientific inquiry and scientific method should be made explicit. We are using as our take-off point what Dewey and Bentley have referred to in a series of articles as a "trans-actional approach."[3] What they mean by the term *transactional* can best be gathered by their own words. "Observation of this general (transactional) type sees man-in-action not as something radically set over against an environing world, nor yet as merely action 'in' a world, but as action *of* and *by* the world in which the man belongs as an integral constituent" (*4*, 228). Under this procedure all of man's behavings "including his most advanced knowings," are treated as "activities not of himself alone, nor even as primarily his, but as processes of the full situation of organism-environment" (*6*, *506*). "From birth to death every human being is a *Party*, so that neither he nor anything done or suffered can possibly be understood when it is separated from the fact of participation in an extensive body of transactions—to which a given human being may contribute and which he modifies, but only in virtue of being a partaker in them" (*3*, 198).

Dewey and Bentley distinguish this transactional procedure from two other procedures which they feel have largely dominated the history of science up till now. First is what they call the antique view of "self-action; where things are viewed as acting under their own powers." Second is the interaction view of classical mechanics, "where thing is balanced against thing in causal interconnection." In transactional observation, "systems of description and naming are employed to deal with aspects and phases of action, without final attribution to 'elements' or other presumptively detachable or independent 'entities,' 'essences,' or 'realities,' and without isolation of presumptively detachable 'relations' from such detachable 'elements'" (*6*, 509).[4]

While it is easy enough to understand this point of view intellectually, it is not nearly so easy to put it into operation in pursuing actual scientific inquiry. It tends to go against the grain of the psychologist's working procedures to regard any formulation merely as a certain "connection of conditions" (*2*, 217). And it is perhaps particularly difficult for psychologists to understand the full implications of the transactional point of view, because, as Dewey and Bentley have pointed out, "The interactional treatment, as everyone is aware, entered psychological inquiry just about the time it was being removed from basic position by the physical sciences from which it was copied" (*7*, 546). But we must remember that psychology, by comparison, is still in its infancy, that the transactional approach, which Dewey and Bentley trace to the preface of Clerk Maxwell's *Matter and motion*, dated 1877, antedated the first psychological laboratory.

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[3] Since this article was written, Dewey and Bentley have brought together in a single volume, *Knowing and the known* (Boston: Beacon Press, 1949) references *3*, *4*, *5*, *6*, and 7 cited here together with other articles previously published by them.

[4] In citing these distinctions made by Dewey and Bentley we are not implying (and they may not be) that in our own view either self-action or interaction can by any means be completely ruled out in any adequate explanation. Self-action is seen in the behavior of the simplest bodily cell, in the uniqueness *of* individual behavior, in the behavior of "nations," etc., while interactional assumptions appear to be essential first steps in providing an intellectual grasp of the form for the flow of transactional processes. The role of self-action and interaction in an inclusive transactional view must be left open as a problem, and cannot be considered here in detail.

(*This is the first of a series of three articles.*)

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The MIT International Conference on the Physics of Very Low Temperatures, September 6–10, 1949

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LOW TEMPERATURE PHYSICS is a field which has been slow and deliberate in its growth. During the last century a group of brilliant experimenters succeeded in liquefying one after another of the "permanent" gases, until finally helium succumbed, and there were no more left to conquer. This early work was international: England, Holland, France, a number of countries took part in the progress. Then during the first years of the present century a great laboratory devoted entirely to very low temperatures was set up at Leiden, by Kamerlingh Onnes. A succession of brilliant discoveries came from this great installation, and established it as the foremost laboratory of the world in the field. It was not long to stand unchallenged, however. In England, Kapitza pioneered in the modern school of low temperature work, at Cambridge; there the Royal Society Mond Laboratory was founded, carrying on in the field after Kapitza's departure for Russia, and today, is one of the leading English low temperature laboratories. The Clarendon Laboratory at Oxford, profiting from the departure from Germany of some of the leading low temperature workers of that country as a result of Hitler's policies, has built up a low temperature laboratory of the first magnitude. The Russian school of low temperature physics, established by Kapitza on his return to that country, forms one of the leading groups in the field. In Canada the laboratory at Toronto, in the United States those at the University of California and the National Bureau of Standards, were working before the war. A few other institutions have been active, but before the war it was a branch of physics confined to a few places, largely because of the magnitude of the installations required, and the difficulty of the experimental techniques encountered.

Since the war, the interest in low temperature physics has greatly increased, particularly in the United States. There are probably two quite different reasons for this. One is a practical, experimental one. The development of new techniques of liquefaction, as a result of work undertaken for military purposes, has made the production of liquid helium (at least in this country, where the helium itself is plentiful) no longer a major undertaking, but a relatively easy task. This has led a considerable number of laboratories to move into the fascinating field of low temperature research, perhaps partly unaware of the fact that the production of liquid helium is only a small part of the experimental problem encountered in getting significant new scientific results. The other reason for the increasing interest in very low temperatures is probably the attraction of a field where major problems still stubbornly refuse to yield to theoretical explanation.

There are probably three principal lines of low temperature research at present: superconductivity, the properties of liquid helium, and low temperature paramagnetism, with its related technique of adiabatic demagnetization. The first two of these still defy all attempts at the construction of theories. It is true that partial theories exist; but they are very far from being complete or satisfactory. This is the only point at which the study of matter in bulk still shows the qualities of a challenging puzzle, qualities which are so characteristic of nuclear physics. Until the physicist can explain these strange facts, he will not rest content.

The other active field, low temperature paramagnetism and adiabatic demagnetization, shows no such mysteries, but it nevertheless has its particular reasons for being interesting just now. It relates to the energy levels of electronic spins in crystals. These energy levels are associated with absorption frequencies in the microwave part of the spectrum; and the greatly expanded interest in microwaves as a result of wartime developments has turned physicists in this direction. Not only the electronic, but also the nuclear resonance is concerned in these properties; very shortly after the war, it was found that nuclear absorptions occur in the radiofrequency part of the spectrum. These studies lead to an exciting possibility: just as the adiabatic demagnetization using electron spins has led to the lowest temperatures so far attained, a few thousandths of a degree, so there is the possibility that use of nuclear resonance may make it possible to reach temperatures of the order of millionths of a degree.

Before the war, there were relatively few low temperature physicists. They had meetings, among others, every four years in connection with the Refrigeration Congresses of the International Institute of Refrigeration, an organization largely devoted to the practical side of refrigeration, but having a very active committee, largely stimulated by the group at Leiden, concerned with the fundamental side of very low temperature research. This organization became dormant during the war, but in July 1948, at the Amsterdam meeting of the International Union of Pure and Applied Physics, a group of low temperature workers was called together, at the initiative of Gorter of Leiden, to consider reviving the international meetings of low temperature physics. Two suggestions were made: either to encourage the International Institute of Refrigeration to resume its activities, or to organize a Commission on the Physics of Very Low Temperatures under the auspices of the International Union of Pure and Applied Physics, an organization which has been much more active since the war than before. Even better than either of these suggestions was the possibility of following both of them. This is essentially what is being done.

The International Union of Pure and Applied Physics was already in active existence, it was known to be favorable toward a suggestion for forming a low temperature commission, and Gorter and Slater, both of whom were at the Amsterdam meeting, were vice presidents. Accordingly it was felt that a meeting could be arranged more expeditiously through this union than through the International Institute of Refrigeration. The suggestion was made that a conference be called for 1949, associated with the Union of Physics, preferably in America, and an invitation was at once issued by the Massachusetts Institute of Technology. It is this conference which has just occurred. On the other hand, the other approach was not neglected. The scientific committee of the International Institute of Refrigeration has been reestablished, under the joint presidency of F. E. Simon of Oxford and C. J. Gorter of Leiden, and it is actively working on plans for a future conference on the physics of very low temperatures, under the joint auspices of the Institute of Refrigeration and the Union of Physics, to meet probably in England in 1951. Meanwhile, the low temperature commission of the Union of Physics has been constituted, under the presidency of Simon, with Gorter acting as secretary, and it held its first meetings in connection with the MIT conference.

The planning of the MIT conference was carried out by Simon, Gorter, and Slater, with much use of the airmail, as well as personal discussions on the occasion of the Amsterdam meeting, and at more recent opportunities. It was realized from the first that, in order to have a truly international meeting in the United States, most of the leading workers in the field would have to be present, and this would involve securing of funds, in dollars, enough to make possible the journey of a considerable number of scientists across the ocean. The preliminary estimate was sixteen, and this proved to be remarkably accurate: just this number had the major part of their traveling expenses paid, as well as several to whom partial payments were made, and several others who found other sources of funds, so that some twenty-five European workers were present.

Application for funds was of course made to the International Union of Pure and Applied Physics, which has at its disposal small grants which come from Unesco. Largely through the friendly interest and efforts of Professor Fleury, secretary of the union, funds to the amount of $2,500 were secured, intended principally for the traveling expenses of the members of the Commission of the Union. It was obvious from the first that the major part of the support would have to be raised from American sources, in dollars, and it was an interesting experiment in the financing and arranging of international conferences in this country to see how difficult this would be. Fortunately, we appealed to President Killian, of MIT, for suggestions, and he personally agreed to help with the securing of funds. Through his efforts, successful appeals for support were made to the Research Corporation, which made a contribution of $5,000, and Arthur D. Little, Inc., which contributed $2,500. In addition, MIT itself agreed to make a substantial contribution. Without these sources of funds, the conference could not have been held.

Announcements were sent to a fairly large mailing list, with requests for suggestions of additional persons who should be invited, and it was possible to invite all those who were thus suggested. This procedure was one which had been used for other MIT conferences on various subjects, and it seemed to be a good compromise between a very small, exclusive conference, and a very large one, announced publicly, with no semblance of an invitation list, which plan we at no time considered for the present conference. The result of this procedure was an attendance of about 200.

Two other conferences were in a way combined with this one. In the first place, the Office of Naval Research arranges small, closed conferences at periodic intervals for its contractors who are working in the low temperature field, a group which includes almost all the principal low temperature laboratories in the United States. They agreed to omit the conference which they would have scheduled at approximately the time of the MIT conference, feeling that that would adequately take its place. In addition, a group in the United States had scheduled conferences on low temperature calorimetry at periodic intervals, often in conjunction with the ONR conferences. Members of that group were also invited and held their conference on one of the days of the larger conference, in parallel with it (see *Science*, 1949, **109**, 348). Thus a considerable number of industrial representatives were present, a fact which should prove to be a stimulus to low temperature work in industry in this country.

In arranging the program, as in choosing the membership of the conference, there were two possibilities: to have only invited papers, suggested by the committee, or to throw the meeting open to a wider group of speakers. Here again the choice was for the wider invitation, since we felt that there were many cases where speakers whose work was not well known to the committee might have important and interesting contributions to make. Accordingly the possibility was opened for any one attending the conference to suggest topics on which he would like to talk. This resulted in a rather full program; the only restriction which the committee placed on the suggested papers was that they should represent rather new work. The consensus of those attending the conference was that, though the meetings were strenuous, there was great value in getting a more complete view of the field.

The papers on the program fell naturally into a few main divisions, based on the current fields of interest in low temperature research. There was liquid helium, with numerous speculations about the theory of the superfluid phase, new results on the liquid helium film, and much new information on the behavior of the isotope He^3, which appears not to show the superfluid behavior, lending support to the hypothesis that it is the Bose-Einstein statistics (which govern the behavior of He^4 but not of He^3) which are responsible for some of the peculiar properties of liquid helium. Paramagnetic resonance, nuclear resonance, and adiabatic demagnetization came in for a good deal of discussion. There were a number of papers on superconductivity, both theoretical and experimental. Interesting low temperature effects on electrical conduction, semiconductors, diamagnetism, and various other topics were discussed; and there was a session on helium liquefiers, including a treatment of the Collins cryostat, developed at MIT during the war, and perfected by Arthur D. Little, Inc., which has furnished much of the recent impetus to the development of low temperature work in this country.

All of the topics of present interest in low temperature research were covered; and, more important, all the important laboratories were represented by their principal workers, so that discussion was lively and authoritative. Nearly everyone whose earlier work was mentioned was in the room, ready to comment on the papers. The only important group missing was that from Russia. They were invited, but sent their regrets, the term in Moscow starting too early to permit their attendance. Unfortunately, their letter of regret, enclosing numerous reprints, reached Cambridge too late to be reported at the conference, but their work was of course well known to the other research groups, and was thoroughly considered at the conference.

The members of the conference lived together at a new dormitory on the MIT campus. In many ways the most useful feature was the way in which all the workers in the field became acquainted. Many of the European visitors had opportunity not only to visit Cambridge for a longer period than the actual week of the conference, but to visit numerous other American low temperature laboratories. Such an interchange of acquaintance and ideas can well be invaluable in advancing the field of low temperature research. A number of the European workers spoke of the stimulus which they received as a result of the opportunity to hear in a connected way the whole present status of the low temperature field. Much greater than this, however, was the benefit to the American scientists, many of whom were new to the field, and who had the opportunity to come to know the masters of the subject personally and to learn at first hand of the difficulties and intricacies of research in this difficult field. The conference may well have had the effect of speeding up by a number of years the time when the many new American groups in low temperature research will get through the process of learning techniques, and will be able to start making significant contributions.

Based on the introduction to the Proceedings of the Conference on Low Temperatures, to be published shortly by the Research Laboratory of Electronics of the Massachusetts Institute of Technology.

Nancy Colloquium on the Mechanism of Carbon Combustion, September 27–30, 1949

Lothar Meyer

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THE REACTION OF CARBON WITH OXYGEN is probably the chemical reaction used more than any other one. However, our knowledge of its mechanism is still surprisingly limited. It was, therefore, of great general interest that the Centre Nationale de la Recherche Scientifique of France organized a colloquium on the combustion of carbon, in Nancy, France, September 27–30, 1949. Only about twenty-five to thirty scientists invited from France, Belgium, England, and this country participated. In this way a splendid opportunity was created for a thorough exchange of opinion in a field where there are many discrepancies between the different investigations.

The colloquium was opened by Professor Terroine, president of the foreign relations commission of the center, who welcomed the visitors and stressed the importance of research and the exchange of ideas for postwar recovery.

The first day was devoted to fundamental research. R. Strickland-Constable (London), X. Duval (Nancy), and L. Meyer discussed the reactions of pure graphite with pure oxygen, CO_2, H_2O, and N_2O under such conditions (*e.g.*, very low pressures) that one can be reasonably sure of investigating only the primary reaction of the attacking gas with the solid surface. Such investigations were initiated in 1915 by I. Langmuir, who even then found contradictory results. The discrepancies between the more recent investigations are still far beyond ordinary experimental errors and are probably due to the peculiar properties of graphite.

There exists an almost continuous transition from amorphous carbon to graphite. Graphite itself has a great tendency for "stacking errors." The graphite crystal consists of parallel planes of carbon atoms arranged in neat hexagons and held together by strong chemical bonds. Each plane is held to the next by comparatively weak van der Waals forces. Even if the planes are parallel to each other there still exists a great variety of possible "disorder" in the sense that the planes may be rotated relative to each other around the hexagonal axis.

Miss R. Franklin (*Paris*) reported on a very interesting systematic investigation of the transition from amorphous carbon to graphite over different crystal sizes and different degrees of order. The distance between ordered planes is 3.34 A, but increases to 3.41 A if a stacking error occurs. The apparent distance found in x-ray pictures depends on the degree of order, as it is the average of the number of ordered and the number of disordered distances.

Usually stacking errors and similar faults in crystals produce only effects of second order. In graphite they apparently have a strong first order influence on physical properties (such as electric conductivity) and kinetic behavior in chemical reactions. The amazing discrepancies in kinetic investigations (not only of the primary reaction but also technical investigations) probably must be blamed on differences in degree of order and crystal size. H. L. Riley (Worksop, England) emphasized, therefore, the necessity for a better correlation of systematic structure investigations with kinetic research.

Audubert and Busso (Paris) reported on experiments to measure and evaluate the radiative effects of the reaction $C + O_2$. Daudel (Paris) discussed the properties of graphite from the point of view of quantum mechanics, and Busso compared these calculations with experimental evidence.

The contributions about the reaction of carbon in the form of fuel under conditions similar to the technical processes revealed such an amazing amount of detailed experience (partly due to British wartime research) that it is impossible to give a short account. The group (D. T. A. Townsend, D. H. Bangham, H. C. Crone, J. R. Arthur) representing the British Coal Utilization Research Association (BCURA, Leatherhead, England) presented extensive material about widely differing problems such as the role of peroxides in the oxidation, the modes of burning of fuel, the mechanism of energy release, and the influence of impurities on the mode of combustion. The latter problem was also discussed by K. W. Sykes (Swansea, England) on the basis of wartime research results. E. Mertens (Louvain, Belgium) and Arthur (BCURA) tried to determine the primary reaction of combustion at the surface by adding substances which inhibit secondary reaction in the gas phase. Prettre (Lyon, France) gave a short report on an improved method of calculating producers.

M. Letort (Nancy) and his co-workers presented new details about the "supercombustibility" discovered by Letort. If a fuel is kept at reaction temperature in an indifferent atmosphere—such as N_2—after having burned for a time, the reactivity increases strongly. By repeating this treatment the reactivity can be increased up to five times the initial one.

Papers and discussion remarks were given in English and French. P. Goldfinger (Brussels, Belgium) acted as interpreter; his summaries in the language not used by the speaker were in themselves a valuable contribution to the discussion.

All contributions and the full discussion will be published shortly in *Journal de Physique et de Chimie*, Paris.

The organization of the meeting (by M. Letort, Nancy) was an impressive example of French hospitality. Receptions by the mayor of Nancy and the director of University of Nancy in the respective historic buildings, a night visit to the ancient Ducal Palace, visits to the modern foundry at Pont à Mousson (at whose ancient university Pere Marquette was professor before coming as an explorer to this country) and the salt mine at St. Nichlas gave excellent opportunities to get acquainted with different aspects of life in France. One was convinced that the heroic efforts of France, not only to repair the material damage of the war, but also to keep alive her great cultural tradition, have been amazingly successful.

Symposium on Brucellosis, September 22–23, 1949[1]

James T. Culbertson

National Institutes of Health, Bethesda, Maryland

A SYMPOSIUM ON BRUCELLOSIS was held at the National Institutes of Health, Bethesda, Maryland, September 22–23, 1949, under the auspices of the National Institutes of Health, the Bureau of Animal Industry, and the National Research Council. The meeting was organized by C. L. Larson, National Institutes of Health, and C. K. Mingle, Bureau of Animal Industry. Dr. Larson served as chairman at all sessions.

In the opening paper, Alice C. Evans (Bethesda, Maryland) described the early history of brucellosis and the studies which led up to the recognition, in 1918, of the relationship between the *Brucella melitensis* and *Br. abortus* organisms. Dr. Evans advised that the term *undulant fever* be dropped from medical literature because of its erroneous implications. The remainder of the first session was devoted to a discussion of brucellosis in farm animals and its control in the animal population. C. A. Manthei (Bureau of Animal Industry) reported that the artificial immunization of cattle with Strain 19 of *Br. abortus* reduced the duration and severity of the infection following exposure to virulent organisms. Aureomycin had not proved effective in the treatment of cattle infections. L. M. Hutchings (Purdue University), from study of the porcine infection with *Br. suis*, concluded that no satisfactory method of vaccination was yet available, and that the results obtained thus far with aureomycin, streptomycin, and the sulfonamides in therapy of the disease in swine have not justified field trial of these agents. W. L. Boyd (University of Minnesota) pointed out that brucellosis may occur in such farm animals as goats, sheep, horses, dogs, cats, and poultry, although only in the goat and horse, among those species just named, is the infection significant in either human or veterinary medicine in the United States. In closing the morning session, H. L. Gilman (Cornell University) emphasized the importance of the slaughter of infected animals, particularly sporadic reactors, as a method of controlling the spread of brucellosis.

In the afternoon session of the first day B. T. Simms (Bureau of Animal Industry) brought out the fact that as long as the present mobility of the livestock population is permitted, contagious diseases such as brucellosis cannot be stopped at state boundaries. The federal government must work with state livestock sanitary authorities in developing uniform methods of attack on the disease, and aid in preventing reinfection of areas where herds have been accredited. Jacob Traum (University of California) discussed *Br. abortus* Strain 19 vaccine, as used in extensive field trials in California. Robert Pennell (Sharpe and Dohme, Inc.) summarized the research on the fractionation of the *Brucellae* into constituent antigens. As yet, it is not possible to differentiate the species of *Brucella* by chemical means. Proteinnucleates of moderate serological activity and other complexes of high activity have been isolated from

(*Continued on page 485.*)

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[1] The papers presented are to be published in monograph form by the American Association for the Advancement of Science.

TECHNICAL PAPERS

The Liver Cord Concept after One Hundred Years[1, 2]

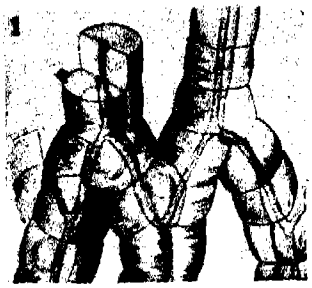
Hans Elias

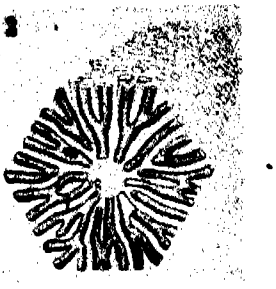
Communicable Disease Center, U. S. Public Health Service, Atlanta, George[3] *and Department of Anatomy, Chicago Medical School*

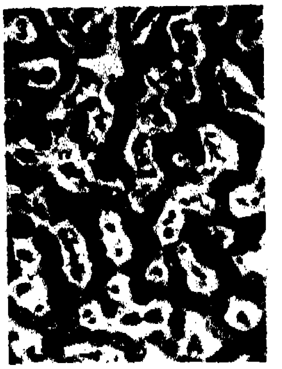
One hundred years have passed since Gerlach (*5*) stated that the liver parenchyma consists of hepatic cells in linear arrangement. This concept has been developed, chiefly by Beale (*1*), and Pflüger (*9*), into the theory of the hepatic cord, almost universally accepted by the authors of modern textbooks. Accidentally, in the last year of its first century of existence, the validity of the liver cord theory came to be questioned.

A film strip on the histology of the liver for use in medical schools was prepared according to the description found in standard textbooks. This film strip consisted of stereograms, and presented the liver as composed of cords of cells (Fig. 1), surrounded by blood spaces called sinusoids. The liver cord is a double row of cells, as all textbooks agree (except Sharpey-Schafer's [*10*]). A bile capillary runs between the cells through the center of the cord. The textbooks have also agreed that these cell cords, columns, or trabeculae anastomose with one another and are in essence arranged radially around the central vein of each liver lobule (Fig. 2). The film strip was prepared according to these conceptions.

After completion of the stereograms for the film strip, it seemed essential to supplement the view diagrammatically presented by means of wax plate reconstructions and photomicrographs. It seemed easy to find longitudinal sections of cords (Figs. 3 and 4) in sections perpendicular to central veins. But the long rows of cells seen invariably in such sections are all too numerous. If tortuous but linear columns did exist in radial arrangement about the central vein, the chances of cutting them lengthwise with the microtome for any considerable distance are very slight. There should not be more than one longitudinal section of cord per microscopic field at high power, even in sections perpendicular to a central vein. The majority of sections of cords, if they did exist, should be oblique, i.e., about three to four cells long. While it had been suspiciously easy to find apparently longitudinal sections of cords, it was practically impossible to find cross sections of cords, despite the fact that they should be very numerous in tangential sections of a lobule (see Fig. 2). In man (Fig. 5) and the cat, sections parallel to the central vein showed long rows of cells simulating cords.







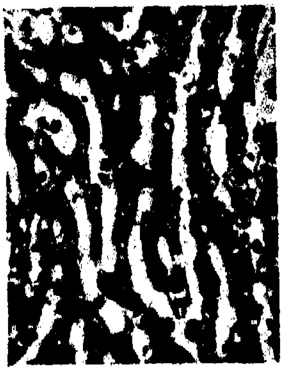


FIG. 1. Stereogram of the conventional concept of anastomosing liver cords, containing axial bile canaliculi.

FIG. 2. Conventional interpretation of the structure of an hepatic lobule.

FIG. 3. Section of human liver lobule perpendicular to central vein. The arrow points to a cross section of an interlaminary bridge.

FIG. 4. Section of liver lobule of horse, perpendicular to central vein. This, as well as the preceding section, consists of long rows of cells, one cell wide.

In whatever direction we may cut a human or cat liver lobule, we always obtain long linear rows of cells. And at widely scattered places we find isolated patches of hepatic cells in an epithelial arrangement (Fig. 6).

The liver of man and the cat, hence, can *not* consist of cords or columns. It must be fashioned of structures which will show, in almost whatever direction they are sectioned, long rows of cells one cell wide, and which at a few places may give sections appearing as larger epithelial masses. Clearly, the formations that can yield these sections cannot be anything but curved plates, sheets, or laminae, one cell thick.

This logical conclusion can easily be verified by means of wax plate reconstructions and also by examining thick, unstained sections mounted in glycerin. Fig. 7 shows a group of hepatic plates drawn with the camera lucida from a section perpendicular to a central vein and 30 µ thick. The plates are curved, frequently perforated, and

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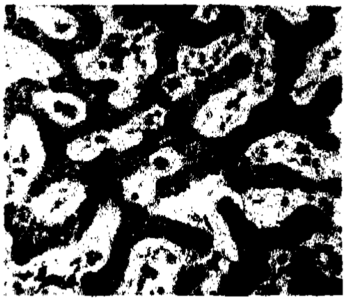
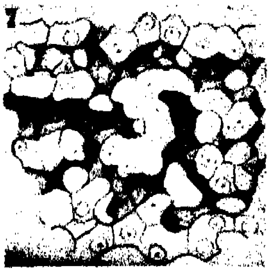
[1] The contents of this report are being described and discussed more thoroughly in the *American Journal of Anatomy.* The paper was read before the American Association of Anatomists, April 23, 1948, and abstracted in *Anat. Rec.*, 1948, 100, 28.

[2] A preliminary report.

[3] From Production Division, Atlanta, Georgia.

wherever they are cut the section is a row of cells one cell wide. It is clear that sections cutting these sheets in other directions will appear as single rows of cells. But it will also be possible, if the level and angle of cutting is favorable, to obtain tangential sections of these laminae, such as the section shown in Fig. 6. In the upper left-hand corner of Fig. 7, unicellular bridges can be seen connecting neighboring plates. Such unicellular and sometimes bicellular bridges account for the occasional occurrence of apparent cross sections of cords, as seen at the tip of the arrow in Fig. 3.





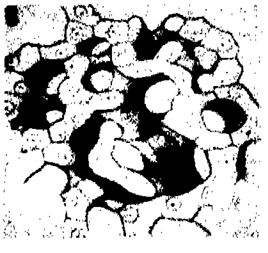


FIG. 5. Section of human liver lobule parallel to central vein. Also in this direction, long rows of cells, one cell wide, are seen. Note the incompatibility of this as well as of the succeeding section with Figs. 1 and 2.

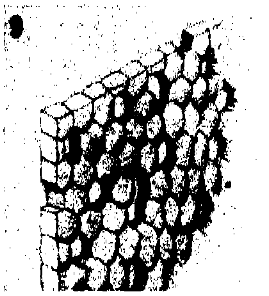
FIG. 6. Tangential section of liver plate (lamina hepatica) of cat.

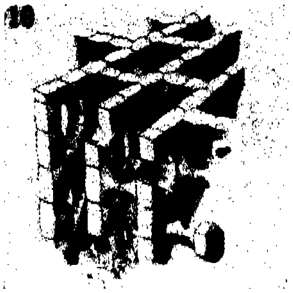
FIG. 7. Liver of cat, showing anastomosing, cribriform, curved, hepatic plates. The spaces which they surround are irregular in shape. Camera lucida drawing of frozen section, 80 μ thick, cut perpendicularly to central vein, not stained, mounted in glycerin.

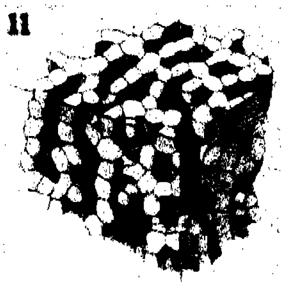
FIG. 8. Liver of cat, showing anastomoses of hepatic plates, saccular shape of hepatic lacunae, interlaminary bridges (upper left), perforations of laminae. Technique as in Fig. 7, sectioned parallel to central vein.

Fig. 8 shows a 30-μ-thick section parallel to a central vein, from the same cat's liver as seen in the preceding figure. It shows that the tortuous laminae anastomose with one another and form wide tubes with irregularly curved, and undoubtedly flexible, walls.[4] We are looking into these saccular lacunae which run toward the central vein. But we are following their course for a distance of only 30 μ. Wax plate models showing the same arrangement were obtained by taking serial, optical sections with the motion picture camera, moving the microscope's fine adjustment from frame to frame for 1 μ.

For the conventional idea of the hepatic cord, consisting of a double row of cells (Fig. 1), there must, therefore, be substituted the concept of the hepatic lamina (Fig. 9) which is one cell thick and frequently perforated to permit the passage of sinusoids. However, hepatic sheets are not straight and they never occur isolated. They form a continuous tissue of connected walls which enclose between them the spaces in which the sinusoids run. This arrangement is shown schematically in Fig. 10. In reality, the plates are curved as seen in Fig. 11. The liver of man and the cat may tentatively be called the saccular type of liver, since the spaces between the plates have the character of long sacs.







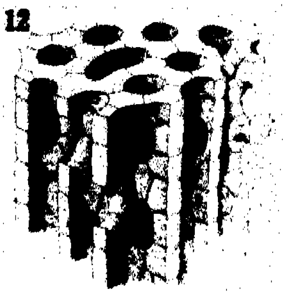


FIG. 9. Schematic stereogram of hepatic plate.

FIG. 10. Schematic stereogram of the saccular liver. Note interlaminary bridges.

FIG. 11. Semidiagrammatic stereogram of the human liver (hepar sacculare).

FIG. 12. Stereogram of the equine liver (hepar tubulare).

A second type of liver is to be found in the horse and in the rabbit. This is the tubular liver, one in which the spaces between the hepatic laminae or walls are narrow and cylindrical. Fig. 13 shows some of these tubes from a horse, cut longitudinally, that is, perpendicularly to the central vein of the lobule. Fig. 13 is also a 30-μ-thick section, unstained, and mounted in glycerine. As Fig. 4 shows, this tubular type of liver also yields, in thin sections, long single rows of cells. Fig. 12 is a stereogram of the tubular liver.

The knowledge of the laminary liver structure makes it much easier to understand the existence of the well-known polygonal meshwork of bile capillaries. These polygonal networks, which are so easily demonstrated with Golgi's silver method or with Chrzonszczewsky's indigocarmine method, do not fit at all into the conventional picture of columnar liver structure. The bile capillaries run, in the majority of cases, between the cells and form hexagonal, intercellular, and pericellular networks within the liver plates.

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[4] The flexibility of the hepatic laminae becomes obvious in sections of livers from which the blood has been drained, after severe hemorrhages. In this case the lacunae become collapsed.

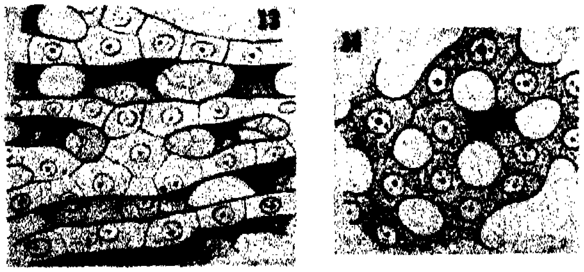

FIG. 13. Liver of horse, showing the tubular character of the lacunae, technique as in Figs. 7 and 8, perpendicular to central vein.

FIG. 14. Same as Fig. 13, but cut parallel to central vein.

From a historical point of view these observations are very interesting. The earliest account of the intimate structure of the liver was given by Gerlach in 1849 and upheld by Beale in 1856 (*1*). Beale described the liver as consisting of membranous tubes which contained rows of liver cells. Basically, this is the conception of modern textbooks. A cell cord surrounded by a network of lattice fibers is essentially the same as a row of cells contained in a noncellular tube.

In 1859, Budge (*4*) raised doubts. He objected to the inadequate methods Beale had used (maceration for days in water, not even in saline, at room temperature; teasing; no use of sections), but he did not find the correct solution.

In 1866, Hering (*6*) analyzed and described, in all correctness and exactly as outlined in this paper, the tubular type of liver (not using this expression) in the rabbit.

In 1867, Kölliker (*8*) described the human liver as a network of tender leaves and strings. Thus, he took a position intermediate between Beale and the view presented in this paper.

In 1869, Pflüger (*9*) ridiculed Hering and upheld the opinion of Gerlach and Beale. Both Beale and Pflüger were prominent men; hence their view was almost universally accepted. Pflüger ignored Kölliker's findings.

Once more, in 1872, Hering (*7*) asserted his viewpoint, bringing more evidence and considering very carefully the geometrical, three-dimensional aspect of the subject. However, his opinion was not accepted.

As late as 1889, Beale (*2*) restated and tried to prove his original concept by obsolete methods; washing the liver through the portal vein with water (not saline), then letting it soak for some time in soda water before beginning to inject his material and observe it with the teasing method. Inadequate as his methods were, Beale nevertheless prevailed, and the most modern textbooks presented the mammalian liver as made of cell columns ensheathed in an argyrophil network.

There are two exceptions to the majority of opinions in textbooks: Braus (*3*) found plates in the liver of man. These are, however, according to him, two cells thick and occur simultaneously with cords which are also two cells thick. The other exception is Sharpey-Schafer (*10*), who described the liver as a parenchyma pervaded by cylindrical sinusoids. This is almost in accordance with Hering, from whom a figure is reproduced. But Sharpey-Schafer does not mention the fact that the walls separating the sinusoids are only one cell thick.

All other textbooks have accepted without question the statements of Beale and Pflüger and perpetuated for 99 years a fundamental misconception of this important organ.

It was the problem of stereographic screen projection of liver anatomy which stimulated a re-examination of the architecture of this organ.

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Perchloric Acid in the Cytochemistry of Pentose Nucleic Acid[1]

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Cytochemical methods for demonstrating pentose nucleic acid (PNA)in tissue sections are based on the removal by ribonuclease of the ability of certain cell constituents to be stained by basic dyes, such as pyronin in Unna's pyronin-methyl green mixture (*1*), methylene blue (*3*), and toluidine blue (*4*). Parallel sections, treated and not treated with ribonuclease, are stained simultaneously and compared. The specificity of the demonstration, of course, depends upon the freedom of the enzyme preparation from proteolytic activity.

Analytical work in this laboratory (*5*, *6*) on root tip homogenates has led to a method for the differential acid extraction of the constituents of PNA and desoxypentose nucleic acid (DNA) into separate fractions, which may

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[1] This work was supported by grants from the American Cancer Society, upon recommendation of the Committee on Growth of the National Research Council, and from the National Cancer Institute.

then be assayed by spectrophotometric or other means. In the procedure used, the homogenate, after preliminary extraction with acidified alcohol, alcohol-ether, and cold 2% perchloric acid, is treated with 10% perchloric acid for 4–18 hr at 4° C. This treatment removes PNA but not DNA from the residue, and appears to have practically no proteolytic effect. Subsequent treatment with perchloric acid at an elevated temperature removes DNA from the residue.

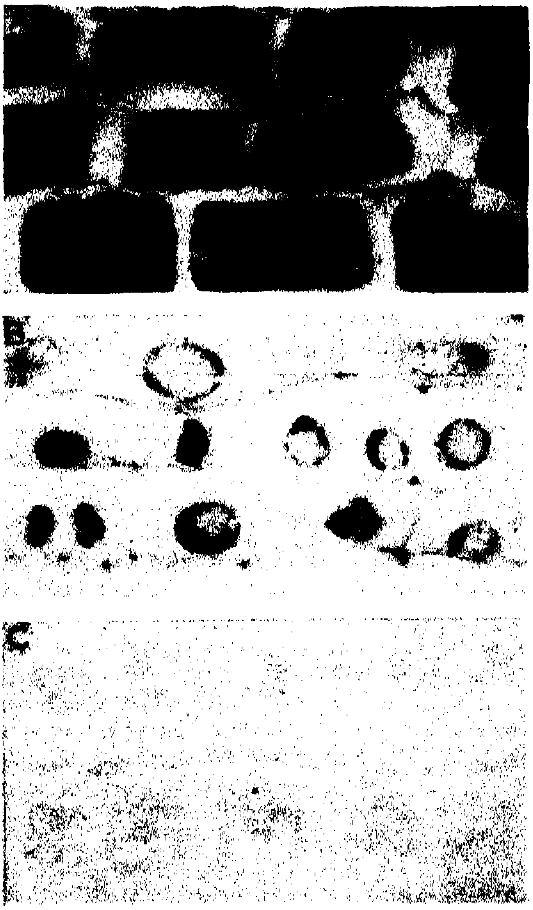

FIG. 1. Meristematic cells from nearly adjacent sections of a single primary root tip of *Zea mays*, fixed in ethyl alcohol, stained simultaneously in toluidine blue, and photographed identically, × 1,000. A—Untreated cells. B—Cells treated with 10% perchloric acid for 18 hr at 4° C. C—Cells treated with 5% perchloric acid for 20 min at 70° C.

Similar treatment of sectioned material might be expected to have similar effects. In particular, it should be possible to use cold perchloric acid, instead of ribonuclease, together with a basic dye to demonstrate PNA in sections. We have attempted such a demonstration in root tip sections. Although several problems, mainly of fixation, require more study, the results to date appear to be of sufficient interest to warrant publication.

In the experiments reported here, primary root tips of *Zea mays* seedlings have been fixed in 75% alcohol for 48 hr, dehydrated, embedded in paraffin, and sectioned longitudinally at 8 μ. The paraffin ribbon obtained from each root tip was cut into segments of two sections. Segments from a single root tip were attached alternately to each of a set of slides, which were then passed through xylene and alcohols to water. This treatment undoubtedly removes water and fat-soluble constituents from the sections, as does the preliminary extraction of the homogenate in the analytical procedure. One or more slides from a root tip were then placed in 10% perchloric acid for 18 hr at 4° C, while control slides were kept in water at the same temperature. Other slides were placed in 5% perchloric acid for 20 min at 70° C, with control slides being given similar exposure to water. All the slides of a set were then washed in water, fastened into a wire clip (*2*), dehydrated together in 70% alcohol, and stained for 3 hr in a 1% solution of toluidine blue O in 75% alcohol. They were destained and dehydrated on the clip, by passing quickly through normal butyl alcohol to xylene, and mounted. Similarly treated slides, which have been passed through the solutions on the same clip, appear to be quite uniformly stained. Sections treated in this way were photographed with a red filter (Corning 2018) at the same exposure and printing times, and at a relatively low degree of contrast (Eastman Panatomic-X film and D-76 developer, No. 1 bromide paper).

Fig. 1, of meristematic cells of a single root tip, illustrates the results of this procedure. Ethyl alcohol is admittedly not a good fixative for plant material. It produces a great deal of shrinkage of the cell as a whole, and does not yield a good image of either cytoplasmic or nuclear structures. From a cytochemical point of view, however, the fixation is simple, and the effect of the perchloric acid treatment is clear. In Fig. 1A, of control cells treated with cold water, the cytoplasm, nucleoli, and chromosomes are strongly stained. In Fig. 1B, of cells treated with cold perchloric acid, neither cytoplasm nor nucleoli stain appreciably, while the chromosomes stain well. In agreement with the analytical findings, treatment of sections with 5% perchloric acid at 70° C for 20 min leaves the cells practically unstainable with toluidine blue (Fig. 1C), whereas the hot water control is indistinguishable from Fig. 1A. Similar sections have been stained by the Feulgen reaction. The chromosomes are Feulgen-positive before and after treatment with cold perchloric acid. After treatment with hot perchloric acid, no staining whatever occurs.

It appears from these results that treatment of sectioned material with cold and hot perchloric acid should be useful in the cytochemistry of the nucleic acids. The cold perchloric acid treatment, which appears to be quite comparable to that by ribonuclease, is of particular interest in the demonstration of PNA.

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Molecular Rearrangements in the Sterols V. The Mechanism of Formation of *i*-Cholesterol

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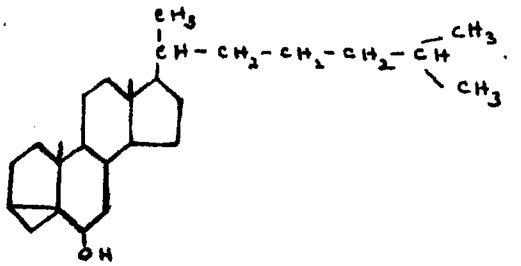
The present accepted structure of *i*-cholesterol (I) was first proposed by Wallis, Fernholz, and Gephart (*9*).



(I)

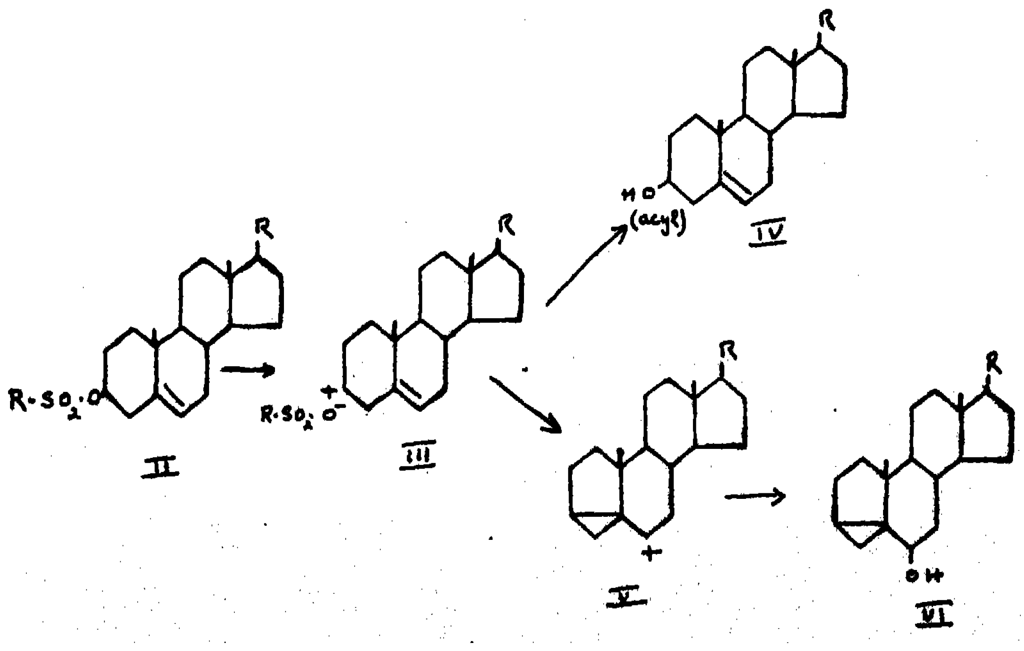
Proof of this formulation has been submitted by Ford, Chakravorty, and Wallis (*4*) and by Ladenberg, Chakravorty, and Wallis (*6*). These investigators (*4, 6, 9*) prepared mixed acetates of cholesterol and *i*-cholesterol by heating cholesteryl *p*-toluenesulfonate with acetic anhydride in the presence of potassium acetate. A mixture of the two isomers was also prepared by Benyon, Heilbron, and Spring (*1*) by hydrolysis of the same ester in aqueous acetone containing potassium acetate. In recent years it has been shown that the formation of *i*-steroids is a general property of all steroid compounds having a hydroxyl group in the β configuration at C_3, and a double bond at C_5—C_6 (*6*).

In this paper we wish to describe the results of certain studies we have made on the mechanism of this isomerization. For this purpose we have carried out the hydrolysis of a series of four sulfonic acid esters of cholesterol with different electron-donating powers in the acid residue. In order further to elucidate the mechanism we have varied the conditions of hydrolysis in the case of one of these esters—cholesteryl *p*-toluenesulfonate. The results of these studies are described in this paper.

From these results it is concluded that rearrangement of II is preceded by ionization—a conclusion in agreement with a mechanism recently proposed by Weinstein and Adams (*10*). The cholesteryl ion III is then either attacked by a negative ion and converted into the normal structure IV or it undergoes a rearrangement to the *i*-cholesteryl ion V, which is similarly converted to the isomeric sterol VI.

The first step of this process is slow. It is followed by a rapid conversion or rearrangement to the corresponding alcohols. On this concept the mechanism is, therefore, of the unimolecular type.

The breaking of the C—O linkage with ionization instead of the S—O linkage agrees with the work of Ferns and Lapworth (*5*) on the hydrolysis of sulfonic acid esters, and with the work of Phillips (*7*) on the Walden inversion of the *p*-toluenesulfonate of benzyl methyl carbinol. In the present instance we believe that our results show that the cholesteryl ion rearranges to the *i*-cholesteryl ion while still *a free ion.* This rearrangement may be looked upon as being the result of an electron shift at the double bond C_5—C_6 towards C_5, thereby binding the cationic center at C_3 and creating another cationic center at C_6. The negative hydroxyl ion or acetate ion, as the case may be, then attacks this new



center, forming *i*-cholesterol or its acetate. If such an attack occurs before the rearrangement of the cholesteryl ion then the normal product is produced.

It should be pointed out that this polarizability of C_5—C_6 double bond is in agreement with the interpretation of Shoppee (*8*) in explaining certain replacement reactions at the C_3 position of cholesterol, which takes place with retention of configuration while the same reactions with dihydrocholesterol result in a Walden inversion.

TABLE 1

PARTIAL HYDROLYSIS, UNDER IDENTICAL CONDITIONS, OF FOUR CHOLESTEROL ESTERS*

Ester	Wt in g	Wt of digitonide	% hydrolysis	K_1/sec
p-Methoxybenzene sulfonate	1.3920	1.2800	68.5	3.2×10^{-4}
p-Toluenesulfonate	1.3520	0.4992	87.1	5.7×10^{-4}
Benzenesulfonate .	1.3170	0.3968	90.1	6.7×10^{-4}
p-Nitrobenzene-sulfonate	1.4206	0.2976	92.6	7.2×10^{-4}

* One four-hundredth mole of the ester and 8/400ths mole of KOAc was refluxed for 1 hr at constant temperature with 50 ml of 90% aqueous acetone. The unhydrolyzed material was completely hydrolyzed with aqueous acetone and a very small amount of KOH. Cholesterol was precipitated as digitonide.

This unimolecular mechanism is also in accordance with the observation (*1, 4, 6*) that no trace of epicholesterol is detected, indicating that the replacing ion does not attach itself to the ester directly, but after ionization. Similarly, the very presence of rearrangement points to a unimolecular mechanism according to the views of Dostrosky and Hughes (*2*).

In Table 1 we have recorded results obtained in partial hydrolysis, under identical conditions, of four cholesteryl esters. The rates of hydrolysis show that the strength of the C—O bond is dependent, as expected, on the electron-donating power of the acid residue. The elimination of the sulfonate ion is facilitated by the weakened C—O bond, and is inversely proportional to the electron-donating power of the acid residue. Although these results can be reconciled with either a unimolecular or a bimolecular mechanism of hydrolysis, the fact that no traces of epicholesterol are formed strongly indicates that the replacing ion does not attack the ester directly and the reaction is consequently unimolecular in nature.

TABLE 2

HYDROLYSIS OF THE FOUR ESTERS IN TABLE 1, CARRIED TO COMPLETION*

Ester	Wt of digitonide in g	% Conversion to *i*-cholesterol
p-Methoxybenzenesulfonate	0.4764	88.1
p-Toluenesulfonate	0.4840	87.9
Benzenesulfonate	0.4800	88.0
p-Nitrobenzenesulfonate	0.4832	87.9

* One four-hundredth mole of the ester and 8/400ths mole of KOAc were boiled for 3 hr with 50 ml of 70% aqueous acetone and then hydrolyzed with alcoholic KOH.

This point of view is definitely shown when the hydrolysis of the same four esters is carried to completion. In this case we find that the acid residue has no influence on the proportion of rearrangement, as is shown in Table 2. The rearrangement takes place in the cholesteryl ion after loss of the acid residue, which then has no effect on isomerization.

It is also of interest to observe the effect on isomerization of varying the water content of the hydrolyzing medium. This effect is shown in Table 3. Similarly, the influence of the potassium acetate concentration is shown in Table 4. Our results show that the lower the concentration of the active reagent, i.e., water and potassium acetate, the higher is the yield of *i*-cholesterol. Again this is understandable in the mechanism described above. The cholesteryl ion has a better chance to rearrange before the attack of the reagent.

TABLE 3

EFFECT ON ISOMERIZATION OF VARYING THE WATER CONTENT OF THE HYDROLYZING MEDIUM*

Concentration of water	Concentration of acetone	% *i*-Cholesterol
5%	95%	89.4
35%	65%	88.8
50%	50%	86.5

* One four-hundredth mole of cholesteryl *p*-toluenesulfonate was completely hydrolyzed in acetone solution in presence of 8/400ths mole of KOAc.

TABLE 4

EFFECT ON ISOMERIZATION OF VARYING THE POTASSIUM ACETATE CONCENTRATION*

Moles KOAc	% Conversion
2	89.5
8	87.9
32	87.0

* *p*-Toluenesulfonate was completely hydrolyzed in 80% aqueous acetone in presence of varying concentrations of KOAc.

There are, however, other alternatives for the rearrangement:

1. The rearrangement occurs concurrently with ionization. This case is very unlikely because the electron-donating power of the acid residue, which governs the ionization, does not affect the proportion of isomerization (Table 2).

2. The rearrangement takes place concurrently with addition of the negative ion at the moment of its attack. This case is unlikely because the proportion of isomerization is changed by changing the water or acetate concentration and it is not apparent how this change would affect isomerization taking place at the moment of attack by a single ion.

3. The cholesteryl ion, first formed, rearranges to form the *i*-cholesteryl ion, but (a) the rearrangement does not reach equilibrium, or (b) the rearrangement does effectively reach equilibrium but the proportion of the two ions is changed by a change in the medium.

It is not possible to eliminate possibilities (a) or (b) on the basis of the data presented here. However, if rearrangement of the cholesteryl ion can be thought of as an intramolecular reaction between an ion (the carbonium ion at C_3) and a neutral molecule (the double bond at C_5—C_6), alternative (b) can be eliminated, because there is no primary salt effect in such a reaction.

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Degradation of Glucose-1-C^{14} and a Possible New Step in the Mechanism of Fermentation[1]

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The availability of glucose-1-C^{14}[3] has permitted the verification of a scheme of glucose degradation applied to sugars formed in photosynthesis to determine the distribution of isotopic carbon within the sugar (*1*). As a result of the present investigation, there appears to be a second, though minor, pathway of fermentation by the test organism, *Lactobacillus casei ε*.

The degradation procedure is depicted in Fig. 1 and involves the following sequence of reactions: the fermentation of glucose to lactic acid; the oxidation of lactic acid to carbon dioxide (carbons three and four of the original glucose) and acetic acid; the pyrolysis of barium acetate to acetone and barium carbonate (carbons two and five); and the formation of iodoform (carbons one and six) from the acetone. The various steps in the process have been tested with (a) methyl- and carboxyl-labeled acetate, (b) α-labeled lactate,[4] and (c) glucose-1-C^{14}.

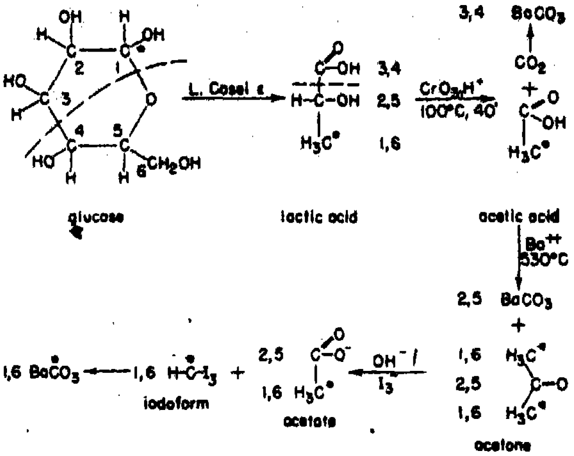

FIG. 1.

Both methyl- and carboxyl-labeled acetates have been pyrolyzed under a variety of conditions, a number of which can be so unfavorable (e.g., that at 450° C with flowing argon), as to result in the appearance of more than 8% of the activity of methyl-labeled acetate in the purified residual barium carbonate. Under similar conditions, with carboxyl-labeled acetate, less than ½ of 1% of the activity is in the iodoform. Using flowing argon, at a temperature of 530° C for 10 min, and liberating the carbon dioxide from the residual carbonate with lactic acid, only 0.86% of the activity of the methyl-labeled acetate is found in the carbonate.

Electrolysis of sodium acetate (*2*), the products of which are carbon dioxide and ethane, resulted in 1% of the radioactivity of the methyl group in the carbon dioxide from methyl-labeled acetate.

The chromium trioxide oxidation of α-labeled lactate (*7*) purified and recrystallized as the zinc salt, resulted in 4.3% of the activity in the carbon dioxide evolved. This activity arises primarily from oxidation of compounds other than the acetic acid itself, as less than 1% of the theoretical barium carbonate arises from acetic acid under identical conditions.

The degradation of lactate from the bacterial fermentation, similarly isolated and purified as the zinc salt, resulted in 9.3 ± 0.1% of the activity in the barium carbonate, rather than the empirical 4.3 ± 0.1. The difference of 5% must be ascribed to the activity of carbons three and four. In fermentation the carboxyl group of the lactic acid is presumed to arise solely from carbons three and four of glucose, whereas in ordinary chemical

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[3] The glucose used by the senior author was synthesized by John C. Sowden (*6*); that used in the California laboratory was synthesized by H. Mahler according to Sowden's general method (*4*).

[4] The acetates were synthesized by Dr. B. Tolbert, and the lactic acid by Dr. R. Lemmon (both at the University of California Radiation Laboratory).

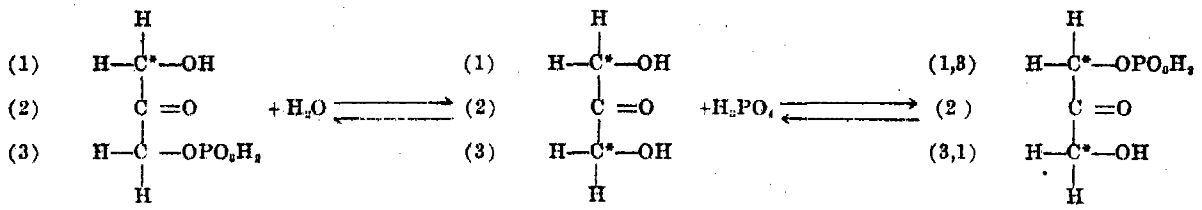

FIG. 2.

alkaline rearrangements resulting in lactic acid (*5*) the carboxyls may stem from carbons one and six. This is certainly so in the case of gluconic acid, where 1.3 moles of lactic acid per mole of gluconic acid can be obtained.

These experiments are in general accord with the recent note by Koshland and Westheimer (*3*) on the fermentation of glucose-1-C^{14} by yeast. In yeast fermentation, the carbon dioxide may be derived from a variety of intermediary products of metabolism. Furthermore, the ability of yeast to fix carbon dioxide is pronounced. In view of these and the rather large counting deviations in their experiments, a quantitative interpretation of their results is not possible.

At least three apparent explanations of our results are suggested, the latter two of which represent deviations from the normal fermentation mechanism: (a) that metabolic carbon dioxide (from the radioglucose) is reversibly reincorporated in lactic acid, in which case the activity would reside primarily in the carboxyl group, (b) that there is a fermentation mechanism in which carbons one and six rather than three and four are oxidized, (c) during the course of the normal fermentation mechanism the triose phosphates are in (partial) equilibrium with the free trioses, as in Fig. 2. This would, of course, result in activity appearing in both carbons one and three of lactic acid, to an extent depending on the amount of approach to an equilibrium. We have not investigated the enzyme systems involved and are thus not able to choose between the second and third explanations. The first explanation appears difficult to reconcile with the fact that the fermentation is conducted in M/10 bicarbonate (pH 6.8), with subsequent dilution of carbon dioxide formed by metabolism. Furthermore, control experiments with inactive glucose but with radiocarbonate (2.8×10^6 disintegrations per min in 5 ml of reaction mixture) resulted in approximately 0.02% of the activity in the lactic acid formed. There still remains the possibility, albeit dubious, that the metabolic carbon dioxide is preferentially used at the site of formation, prior to the diffusion and subsequent dilution effects of the solution's inactive bicarbonate.

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Diurnal Responsiveness of *Erysiphe graminis* to Nutrients

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Because it can be grown readily on barley in the greenhouse throughout the year, because the conidia germinate well on various culture media, and because germ tube growth is sharply increased by a number of nutrient chemicals, the fungus *Erysiphe graminis* D.C. appears well suited to studies of growth *in vitro* of a powdery mildew. No member of the Erysiphaceae has been cultured on a nonliving substrate, and all are commonly regarded as obligate parasites.

Previous studies of *Erysiphe graminis* have indicated no diurnal cycle in the germinability of the conidia or in the division of the generative cell such as is exhibited by *Erysiphe polygoni* (*1*). On an agar substrate, germ tube growth of *E. graminis* is increased by crude animal and plant extracts, especially a solution of hen's egg yolk; by iron sulfate, sucrose (*2*), disodium α-tocopherol phosphate, and Tween 60 (*4*). More recently, a medium consisting of 0.8% agar, 0.6% fructose, and 0.003% animal lecithin has been used. Using this medium, there has been great variation in germ tube length in different trials; such variation being associated, apparently, with the time of day the trials were started.

To check on the effect of time, plates of plain agar and lecithin-fructose agar, prepared simultaneously and stored at 0° C, were seeded with conidia of *E. graminis* from greenhouse plants at various times throughout the day and incubated at 16° C in the dark, and the germ tube growth was measured 5 days after seeding. Results of the first trial, started on February 11, 1949, are presented in Fig. 1, and indicate that germ tube growth on nutrient agar was greatest from seedings made about 12 M., and poorest from seedings made at 8:30 A.M. The germ tubes of the 12:30 P.M. seeding were 85 μ greater or 175% greater than the germ tubes of the 8:30 A.M. seeding. Germ tube growth on nutrient agar was 40% greater than growth on plain agar at 8:30 A.M., and 236% greater than on plain agar at 12:30 P.M. In three subsequent trials, an attempt was made to compare only the approximate peak and trough of this diurnal cycle of responsiveness to nutrients. In these trials, the increase in germ tube length due to nutrients averaged 56% for seedings made from 4:15 to 5:30 A.M., and 244% for seedings made from 11:50 A.M. to 12:20 P.M. (see Fig. 1). In all trials, germination ranged between 25% and 92% and showed no apparent diurnal cycle and no apparent correlation with germ tube length.

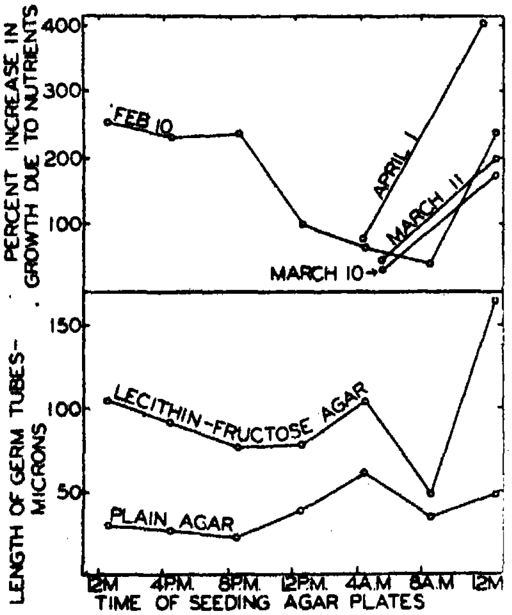

FIG. 1. Diurnal cycle of responsiveness of conidia of *Erysiphe graminis* to lecithin-fructose agar. Each value is the average of 20 germ tubes. Data of the 2 lower graphs are for February 10–11, 1949. The weather was cloudy before and during these tests and also during those of March 10 and 11. The weather was clear before and during the test of April 1.

Concurrent attempts to study in a similar way germ tube growth *in vitro* of *Erysiphe polygoni* from bean, and *Uncinula necator* from grape (both fungi show a clear diurnal cycle of conidiophore maturation, and the bean fungus also shows diurnal variation in sensitivity to copper sulfate [*3*]) failed to evince any marked response to the lecithin-fructose medium at any time tested. This indicates that there are specific differences between closely related species of powdery mildews with respect to nutrient response.

As the principal index of the nutrient value of a test chemical is the difference in growth of germ tubes on media with and without the test chemical, this diurnal responsiveness to nutrients, as in the germinability of the conidia of *E. polygoni* (*1*), is apparently the result of diurnal changes in the fungus while grown on the host plant before use in these tests. Diurnal responsiveness may be of considerable importance in studies of the growth *in vitro* of some powdery mildews.

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A New Method for the Study *in Vitro* of Rumen Digestion

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The utilization of cellulose has long been recognized as a primary factor in the nutrition of ruminants and particularly so among those subsisting largely on roughages. It is believed, therefore, that the rate of cellulose digestion *in vitro* by the microorganisms of the rumen may be used as a measure of how nearly it is possible to approach cellulose digestion *in vivo*.

A technique for the study of digestion in the rumen *in vitro* has recently been published by Marston (*3*). His procedure appears to simulate more closely the natural environment in the rumen than any earlier investigations. There is, however, one significant omission. No provision is made for the removal of nongaseous fermentation products which, as they accumulate, might be expected to slow the rate and eventually inhibit digestion.

To test the influence of such an accumulation of breakdown products, cellulose digestion was compared after incubation with fresh rumen fluid in a closed vessel (the technique of Marston), and in a semipermeable bag suspended in a large volume of aqueous growth medium.

Samples of rumen liquor were collected by scooping semisolid material from the lower regions of the rumen of a fistulated cow and straining this through three layers of cheesecloth, pressing the residue by hand directly into a glass container in which the air had previously been replaced by nitrogen or carbon dioxide. To minimize heat losses, the receptacle was wrapped in paper. After thorough mixing, 700-ml aliquots of this liquor were incubated with 12.0 (and later 20.0) g of Whatman #12 filter paper (ground in a Wiley mill to pass the 0.5 mm sieve), 15.0 ml of 1 M KH_2PO_4, and 7.5 ml each of 2 M $(NH_4)_2SO_4$, 1 M $MgSO_4$ and 0.5 M $CaCl_2$ in a glass bottle and in a semipermeable bag, using the type of apparatus presented in Fig. 1. Two fermentations were conducted at one time in duplicate apparatus, differing only in vessel *B*, which in one was a glass bottle, and in the other a "Visking" cellulose sausage casing of 4½ in. diam. In both, vessel *B* is closed by *a*, which is a wood stopper surrounded by a rubber gasket and coated with wax, and suspended in a 12 × 12-in. water bath *H*. Tubes *c* and *d* serve as inlets and outlets for gas, respectively; tube *e* is connected to a burette containing 0.5 M Na_2CO_3; *g* is a mercury-sealed shaft of an adjustable speed stirrer;

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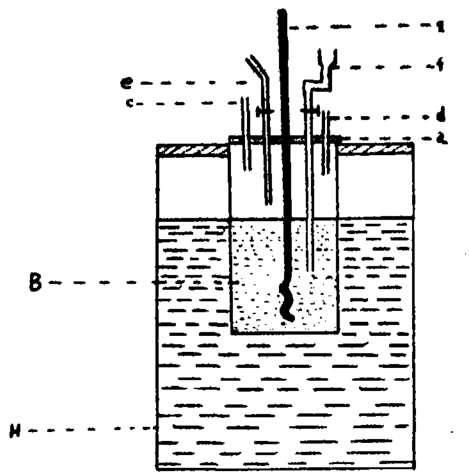

FIG. 1. Apparatus for study of rumen digestion *in vitro.*

and *f* is a tube fitted with a stopcock and a reservoir into which fluid can be drawn for pH determinations. The temperature of the water baths was thermostatically controlled to a temperature of 39° C. After Experiment 1, a current of nitrogen gas replaced the motor-driven stirrer in the bath carrying the semipermeable bag. This ensured adequate mixing as well as improved anaerobic conditions.

Prior to commencing an experiment, tube *c* was pushed well down into the fluids in *B* and a rapid current of nitrogen containing 5% carbon dioxide passed through for about 3 min, after which the tube was raised above the surface of the fluid and the gas flow maintained at a low rate for the duration of the experiment. The pH of the fluids in *B* was then adjusted to 6.8, by running in alkali through *e* while stirring. The inorganic salt concentrations and pH were adjusted in the water bath to the levels inside the semipermeable bag, and the fermentation allowed to proceed at 39° C in both the glass bottle and in the semipermeable bag for a period of 24 hr at or near a pH of 6.8.

The frequency and amount of stirring to which the fermenting fluids were subjected varied with the different experiments, as indicated in Table 1. The pH was adjusted to about 6.8 at 2-hr intervals. As the pH seldom dropped below 6.3 in the course of 2 hr, more frequent adjustments were deemed unnecessary.

At the end of 24 hr, the "brews" were made up to definite volumes, well shaken, and aliquots, usually 50 or 100 ml, taken for the determination of residual cellulose using the method of Crampton and Maynard (*1*). The cellulose content of the rumen liquor before incubation was also estimated.

The production of volatile fatty acids was determined in the final experiment, 4. The volatile acids in the steam distillates were transferred to 25 ml of chloroform containing 10% butanol (CB_{10}), according to a method followed by Elsden (*2*). Total acids were then titrated with 0.1 *N* $Ba(OH)_2$ solution, using phenol red as indicator. Finally, 1-ml aliquots of the CB_{10} extracts were used to separate the total volatile acids chromatographically, according to the method of Peterson and Johnson (*4*), into a propionic acid fraction representing the portion eluted by benzene, and an acetic acid fraction representing the portion eluted by CB_{10}.

Some preliminary data on cellulose digestion during 24 hr are presented in Table 1. In comparison, calculations from Marston's (*loc. cit.*) data showed that he obtained *cellulose digestion to the extent of 5–7 g.*

The variable, so far as could be determined, was the type of container in which the digestions were conducted. Therefore, the differences in favor of the semipermeable bag recorded in Table 1 for all four trials appear to be due only to an inhibitory influence of fission products accumulating in the glass bottle. And if this is so, differences in rates of fermentation may be expected to be greater, the higher the activity of the particular sample of rumen liquor incubated. This is borne out by the results of Experiments 1–3. Precisely what led to these differences in activity in samples of rumen fluid collected, admittedly on different dates, but at the same time of day from the same animal on the same dietary regime, it is not possible to say at present. Mention must be made, however, of the probability that the ideal, according to which the transfer of the rumen liquor from the living animal to the artificial environment should be undertaken with the least delay, exposure to air, and loss of heat, was progressively approached from Experiments 1–3.

For reasons not connected with this work the ration of the cow was changed about a week prior to Experiment 4, from hay plus a concentrate to hay only. Judged by the frequency of certain characteristic churning movements set up periodically in the fermenting liquors by gas accumulating in the cellulose settling gradually to the bottom of the containers and then escaping to the surface, the rumen sample obtained after this change of diet was particularly active. This conclusion was supported by the comparatively high rate of cellulose breakdown registered for the glass bottle in Experiment 4. The rate of fermentation in the semipermeable bag again exceeded that in the glass bottle but not to the extent that might have been expected from results of Experiment 3. An explanation may be the amount of stirring used, as noted in Table 1. The higher rate of stirring applied to the semipermeable bag may have had an adverse effect, in

TABLE 1

In Vitro DIGESTION OF CELLULOSE

Experiment	*Semipermeable bag*			*Glass bottle*		
	Wt in g of cellulose			Wt in g of cellulose		
	At start	Residue	Digested	At start	Residue	Digested
1*	11.89	5.00	*6.89*	11.89	6.91	*4.98*
2*	11.58	3.77	*7.81*	11.58	6.56	*5.02*
3†	19.07	3.42	*15.65*	19.07	10.26	*8.81*
4‡	19.36	6.10	*13.26*	19.36	8.12	*11.24*

* Stirred for 1 min at 1-hr intervals.

† Stirred for 1 min at ½-hr intervals.

‡ Stirring in glass bottle the same as in Experiment 3; stirring in the bag for 3 min at ½-hr and for 10 min at 2-hr intervals.

view of Marston's observation that rapid and frequent stirring caused decreased fermentation.

Results of the analysis of the fermentation products obtained in Experiment 4 are presented in Table 2. These data indicate that: (1) acetic and propionic acids are formed in the same proportions, irrespective of whether fermentation is carried out in the glass or cellophane container; (2) apparently less total volatile acid/g of cellulose digested is formed in the semipermeable bag than in the glass bottle, and (3) acetic acid diffuses at a greater rate from the bag than does propionic acid.

TABLE 2

VOLATILE ACIDS IN "BREWS" AND DIALYZATE AFTER 24-HR FERMENTATION (G)

Acid	Introduced with 700 ml rumen liquor	Glass bottle	Semipermeable bag		
			Inside	Outside	Total
Propionic ..	1.56	5.11	2.58	2.64	5.22
Acetic	2.26	5.28	2.22	2.38	5.60
Total	3.82	10.39	4.80	6.02	10.82

In conclusion it may be mentioned that there was no microscopic evidence of attack by the ruminal organisms on the cellophane bag. This is indeed fortunate, and may be explained on the basis that attack on cellulosic materials usually begins at broken or torn ends and no such surfaces were exposed in these experiments.

This work is being continued to explore ways of improving the technique.

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A Simple Universal Dairy Products Phosphatase Test

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Dairy products vary quite widely in character and composition. For example, there is the extreme contrast that exists between whole milk and ripened cheese. This variability has affected the applicability of standard phosphatase methods to various dairy products. Until recently, the Kay-Graham phosphatase test could not be used for ripened cheese or for chocolate milk products because interfering substances in them turned blue with the Folin-Ciocalteu reagent, resulting in false positive readings.

In addition, in all present-day phosphatase tests, including Sanders and Sager's (*3*), the concentration of the buffer and precipitating agent has to be shifted for many of the dairy products having different buffer capacities. This has led to a great deal of added effort and much confusion.

TABLE 1

SENSITIVITY OF THE CORNELL PHOSPHATASE METHOD WITH FRESH WHOLE MILK AND 15-MONTH-OLD CHEDDAR CHEESE

Milk	Phenol γ/0.5 ml*	Cheddar cheese	Phenol γ/0.25 g*
Pasteurized†	1.3	Made from pasteurized milk	1.2
" + 0.1% raw	14.2	" + 0.1% raw	8.4
" + 0.4% raw	47.0	" + 0.4% raw	22.0
" + 1.0% raw	64.0	" + 1.0% raw	30.0

* Tentatively, any value over 5.0 γ phenol/0.5 ml milk or 0.25 g cheese is considered underpasteurized.

† Pasteurized milk for this test is milk heated to at least 148° F for 30 min.

During the past year, an other extraction technique has been evolved for the elimination of all interfering substances in dairy products when using the Kay-Graham phosphatase method with the Folin-Ciocalteu reagent (*1*). This work also brought out the fact that the barbital buffer used in the Kay-Graham test was unsatisfactory. As a result, a highly concentrated sodium carbonate-sodium bicarbonate buffer was substituted, with excellent results (*2*).

Though the extraction process proved highly satisfactory in improving the Kay-Graham test, information obtained during this investigation pointed toward the development of a very simple procedure for all dairy products without extraction when using 2,6-dibromoquinonechlorimide (BQC) as the color indicator.

The method used in this new test is to incubate dairy product samples with a sodium carbonate-sodium bicarbonate buffer substrate at pH 9.5–9.7 for a period of time, then to precipitate the protein with an acid precipitant. After filtration, the filtrate is brought back to an alkaline reaction with carbonate, and BQC is then added. Blue color is produced if sufficient phosphatase was present in the milk during incubation to split the added disodium phenyl phosphate in the buffer substrate.

This test differs from others in that (1) the buffer and precipitating agent are of different nature, (2) only one concentration of buffer and precipitating solutions is required for all dairy products, and (3) it is not necessary to heat-inactivate the phosphatase enzyme after incubation, since the precipitating agent reduces the milk-substrate solution to pH 1–2.

The details of the method are briefly outlined as follows: 1 ml of milk or fluid dairy product or 0.5 g of cheese or other solid dairy product is mixed with 10 ml of warm carbonate buffer substrate (sodium carbonate 11.5 g; sodium bicarbonate 10.5 g; disodium phenyl phosphate 1.09 g/l).

The test tubes are then incubated at 32–37° C for 18–24 hr. After incubation, 1 ml of an acid precipitant solution (25.0% trichloracetic acid + 18% hydrochloric acid) is added to each tube. The resulting precipitate is filtered off through Whatman No. 42 paper (11 cm).

Five ml of the filtrate is pipetted into a small test tube, followed by the addition of 1 ml of 0.05% copper sulfate plus 2% Calgon solution, and 5 ml of 8% sodium carbonate solution. Then 2 drops of BQC solution (50 mg/10 ml absolute methyl alcohol) are added, and the colors allowed to develop for 15 min at 37° C. The developed colors are compared with suitable standards.

For ripened cheese, the color development procedure is the same, except that 1 ml of 10% Calgon solution is substituted for 1 ml of the copper sulfate-Calgon solution.

Tentatively, for the long incubation method any value over 5 γ phenol/0.5 ml milk or 0.25 g cheese indicates underpasteurization or raw milk products. A 1-hr test using the identical steps but with a different critical standard has also been developed.

The sensitivity and accuracy of this test are very high, and the value of blanks is low. Table 1 shows some data obtained with milk and aged Cheddar cheese.

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Comments and Communications

Electronic Enhancement of X-Ray Film Contrast[1]

A viewing device for x-ray films, which makes use of some principles of television, promises to be of aid in certain long-standing problems of roentgenology. Many films contain questionable faint shadows whose existence and outlines ought to be ascertained definitely. If such a film is scanned by a densitometer, small but distinct differences in density can sometimes be found in homogeneous-looking regions of the film.

A television camera, using an orthicon tube or other scanning device, is employed as a continuously acting densitometer. The electrical output from the camera is amplified, "clipped" as described here, and fed into a kinescope, or viewing tube, as in conventional television practice.

The new feature of this method lies in the clipping. Unlike photographic film, which necessarily has black as the origin of its intensity-axis, a camera-amplifier-clipper combination can be arranged to ignore all light of less than a prescribed intensity. This is possible because a vacuum tube can be made insensitive to voltages more negative than a chosen threshold. The tube can also have an arbitrarily placed upper limit beyond which it fails to respond. Thus the voltages representing the darkest and the lightest portions of the film are clipped off, permitting those parts of the signal between the limits to be amplified as desired.

Thus a suitably high-gain video amplifier with adjustable cut-offs for both the black and the white ends of the signal can expand any portion of the gray to the full contrast of which the kinescope is capable. Everything darker than a certain gray is reproduced as black and everything brighter than another (lighter) gray comes through as white, but the outlines of those areas which have intermediate brilliance but small contrast are vividly portrayed by the picture tube.

Successive parts of the black-gray-white scale can be examined by rotating a knob, analogous to the brilliance control of a television receiver. Let us imagine a solid, formed by erecting a line perpendicular to the film at each point of its surface, each line having a length proportional to the density of its foot. This solid is cut by two planes parallel to the film (one plane representing black on the kinescope and the other white), and the frustum can be examined in detail. The brilliance control regulates the distance of these planes from the base, and the contrast (sensitivity) control adjusts their distance from each other. The result can be metaphorically described as taking serial sections along the density axis of the film.

To date, a few x-ray films have been viewed by this method, and the improvement in contrast is striking, especially when one personally operates the controls and watches the shifts in emphasis. If the kinescope is photographed with the controls properly set, a more vivid picture results than can be taken from the film directly.

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The High School Biology Teacher

Victor A. Greulach (*Science* 1949, **109**, 385) in sharing Dr. Van Overbeek's concern over the inadequacy of high school biology teaching, (*Science* 1949, **109**, 210) exhorts "*professional biologists through their societies to* support a program designed to improve the quality and quantity of secondary school biology."

A practical and more immediately feasible suggestion might be for some university departments of biology to remove—or at least to open—the academic curtain that they keep tightly drawn between themselves and departments of education. I know of one large university in the East in which the zoology department schedules its courses at hours which seem deliberately designed to keep out high school biology teachers.

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[1] The authors wish to express their thanks to the Balaban and Kats Television Studios, Station WBKB, Chicago, for making available equipment for these experiments.

It is gratifying to learn of the preoccupation of at least some professional biologists with improvement of the biology literacy of the American public. National, state, and local associations of high school biology teachers are equally concerned and they would welcome the cooperation of their colleagues in colleges, universities, and research institutions.

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Correction

In my report on the Echo Lakes Symposium on Cosmic Rays (*Science*, September 2, 1949) the π- and μ-symbols were interchanged, in the line before last of the second column, p. 242, and in the first line of the third column in the same page. The portion of the text containing these two lines should read: ". . . the latest values for the masses of the μ- and the π-meson (215 and 285 electron masses respectively) and for the mean life of the π-meson (0.63×10^{-8} sec)." In a recent letter to the writer, Dr. Barkas states that this value for the mean life of the π-meson has been superseded by more accurate measurements. These measurements, made on positive π-mesons, give a mean life of 1.97×10^{-8} sec. Dr. Barkas also indicates that new mass measurements give 276 electron masses for positive or negative π-mesons and 210 electron masses for positive μ-mesons.

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Psilotum Gametophytes Matured under Greenhouse Conditions from Self-sown Spores

Recently, young sporophytic plants of *Psilotum nudum* (L.) Griseb. (Eames, A. J. *Morphology of vascular plants, lower groups.* New York: McGraw-Hill, 1936) were found growing in the pot of a ten-year old *Cibotium* plant and in the soil around a dead *Adiantum* plant taken from the former pot. Mature sporophytic plants of *Psilotum* have been growing for 10 to 12 years in the vicinity of the *Cibotium* plant in the Cornell University Conservatory.

Numerous whole or fragmentary pieces of gametophytes (Darnell-Smith, P. A. *Trans. Roy. Soc. Edinburgh*, 1917, 52, 79; Holloway, J. E. *Ann. Bot.*, 1939, 3, 313; Lawson, A. A. *Trans. Roy. Soc. Edinburgh*, 1917, 52, 93) were found in the soil supporting the sporelings, but none were found in the larger pot where they probably first appeared. Gemmae were observed arising from both the gametophytes and the sporophytic rhizomes as described by Holloway. Antheridia were fairly abundant, and the characteristic four-rowed archegonial necks, both entire and decapitated, were observed on nearly all of the gametophytes. Structures which could unquestionably be called embryos were not seen. During the examination of the gametophytes in water under a dissecting microscope, the heat from the electric light bulb warmed the water sufficiently to cause the antheridia to open apically to discharge the sperms. Under the artificial conditions, the sperms were short-lived and died within an hour or less if they did not come in contact with archegonia. The striking, coiled, hyaline sperms were not seen to enter the archegonia, but apparently to lie down, as it were, and remain across the open end of the decapitated necks.

This brief description of a possible source of gametophytes of a plant so important to morphologists and systematists seems worthy of note, for, insofar as the authors are aware, the gametophytes of *Psilotum* have not before been cultured to maturity, either intentionally or, as here, unintentionally, and such culture is considered impossible by many. Lawson germinated spores under nearly natural conditions but it is not clear from his report whether he grew the gametophytes to maturity or not.

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Rainfall of Fish

With regard to the communication (*Science*, 1949, 109, 402) concerning the rainfall of fish, another pertinent experience may be of interest.

While stationed on the island of Guam in September, 1936, I witnessed a brief rainfall of fish, one of the specimens of which was identified as the tench (*Tinca tinca*) which, to my knowledge, is common only to the fresh waters of Europe. The presence of this species at a locale so remote from its normal habitat is worthy of note.

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Book Reviews

Unitary principle in physics and biology. Lancelot Law Whyte. New York (10): Henry Holt, 1949. Pp. xxiii + 162. $3.50.

The development of fundamental sciences during the first half of the present century was characterized on one hand by clarification of basic principles underlying physical phenomena (relativity, uncertainty, elementary particles), and on the other by much deeper insight into basic phenomena from the realm of biology (interpretation of genes and viruses as single molecules, etc.) which gives us promise of understanding the phenomena of life on a purely physical basis. This led recently to a much closer collaboration between physicists and biologists, and induced many theoretical physicists (for example, E. Schroedinger) to attempt an extension of the well-developed methods of physical theory into the virgin field of fundamental biology. Although, as could well be expected, the development of the theory of organic matter still represents tremendous difficulties, one can hope that further experimental studies of elementary biological phenomena, and more extensive work on their interpretation in the language of molecular physics, will lead in the future (maybe not so distant) to the complete solution of the ancient riddle of life.

That is why one witnesses with a deep chagrin the appearance of such books as one by Lancelot Law Whyte who claims to be able to turn upside down both physics and biology, and to arrange them into new order on the basis of a newly invented philosophical (in the bad sense of this word) principle of ''unitarity.''

It is hardly necessary to discuss in any details the contents of this book, which will be quite unacceptable to all physicists (even to those possessing a great sense of humor), and of little help to any biologist. Thus we will give only a few quotations typical for the entire presentation. The ''Unitary Principle'' from which all laws of physics and biology are to be derived reads:

''Asymmetry tends to disappear, and this tendency is realized in isolable processes.'' In applying this principle to physical phenomena, the author comes to a number of conclusions which, according to him ''*offer a challenge to the theoretical physicists* either to justify them by quantitative confirmation, or to show that they contradict established facts.'' Here are two examples of such conclusions: ''Atom is a stable pattern with one center of (latent) symmetry.'' ''Electronic current (at temperatures not close to absolute zero) is a continued induction, by a chemical source of polarization, of an extended state of polarization (in a conductor) which continually collapses into disordered molecular polarization.''

Having revolutionized physics by these and other similar statements, the author turns to biology and defines, for example, a green plant as: ''. . . a continuous process of local chirol fields stabilized by hereditary units and supported by stationary structures conforming to an external axis.''

Not being a botanist, the reviewer is unable to judge the merits of this definition.

The quotations are sufficient commentary on this book.

George Gamow

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Factors of evolution: The theory of stabilizing selection. I. I. Schmalhausen. (Theodosius Dobzhansky, Ed.; I. Dordick, Trans.) Philadelphia: Blakiston, 1949. Pp. xiv + 327. (Illustrated.) $6.00.

Although its dust jacket calls *Factors of evolution* the ''first full discussion of new contributions to evolution in more than a decade,'' it fails to show any advantage of its recency. It was written six years ago, but the bibliography does not cite any non-Russian papers after 1940, and only a few Russian ones. However, a large body of data from the USSR is revealed, and most biologists should find a number of interesting notes on work in their own field.

This book is directed toward establishing the separation of natural selection into a dynamic role and a stabilizing one. Those factors which tend to change the average phenotype of a population are considered dynamic, while those which tend to preserve the population within a narrow range of variation are considered stabilizing. Schmalhausen focuses attention on that group of factors which have the effect of stabilizing the genetic and morphogenetic systems of organisms, and which, together with the elimination of harmful mutants, form the basis of stabilizing selection.

A broad background of work in genetics is used as an introduction to the book, followed by a discussion of natural selection and its consequences, and then a section on the evolution of morphogenetic reactions. The concluding section consists of a discussion of the factors involved in rates of evolution. In each case the facts are selected to fit into the general picture of stabilizing selection, little attempt being made to present a discussion of the whole field of evolution.

The main value of this book will undoubtedly be in the intensive discussion and work it will generate. This is because the number of interesting ideas presented is large, but often the evidence for them is sufficiently meager or the interpretation sufficiently questionable to warrant much further investigation. The publisher's suggestion for using the book as a text, or its use for any general purpose, should find little acceptance. The language is difficult and often obscure. Readers with a general knowledge of taxonomy or genetics will discover many errors and inconsistencies.

It should be noted that Schmalhausen's ideas come from within the framework of Mendelian genetics. Throughout the book the discussion of the roles of environment and heredity in development are distinctly stated without prejudicing either one. However, the advocacy of Mendelism in this book cost Schmalhausen his position in August of 1948.

HERMAN SLATIS

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From Euclid to Eddington: A study of conceptions of the external world. (The Tarner Lectures, 1947.) Edmund Whittaker. New York: Cambridge Univ. Press, 1949. Pp. ix + 212. $4.00.

Although the title suggests a systematic history of cosmological speculations, and the subtitle hints at a philosophy of science, the present book (containing the substance of the Tarner Lectures for 1947) is in fact neither. Its aim is to outline the development of some of the chief theoretical principles of modern physics, especially those which contribute to the systematic unification of physical knowledge and have a bearing on larger cosmological questions. The volume is thus addressed to readers concerned with the state of current theory; and Whittaker employs historical materials primarily to introduce modern notions and to make evident what is novel in them. His exposition is divided into five parts, dealing in sequence with basic ideas in the analysis of space and time, with the fundamental concepts of classical physics, with the notions underlying general relativity, with the concepts of quantum theory, and finally with Eddington's cosmological views.

Whittaker writes with his customary clarity, though he does assume more than mere literacy on the part of his audience; and he makes excellent use of his unusual mastery of the history of science to illuminate recent attempts at a unified conception of the physical world by showing the relevance of earlier efforts in this direction. Moreover, he expounds the remarkable achievements of modern theoretical physics with contagious admiration and enthusiasm; and his reasonably intelligible account of Eddington's fascinating but not widely known contributions to physical cosmology constitutes a specially useful service to the general reader.

However, the book has little to offer to anyone interested in the philosophical and logical analysis of modern theoretical formulations. Whittaker is indeed often on the verge of interesting methodological reflections, as in his brief comment on electrons as not being "particles in the old sense," or in his over-all remark on the use of alternative models in interpreting the formalism of quantum theory. He also tantalizes his readers by such asides as that recent work on the unified field theory, while marking important contributions to pure mathematics, does not possess much physical significance. It is also evident that Whittaker does not subscribe to the positivist-pragmatist account of the function of physical theory, as is clear from his somewhat negative evalution of Newtonian gravitational theory because of the latter's silence on the origin and mode of transmission of gravitational influences. But none of these essentially incidental observations are adequately developed, and in consequence the reader is never permitted to inspect the intellectual center from which Whittaker surveys and evaluates the fundamental ideas of modern physics.

ERNEST NAGEL

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Atmospheric electricity. J. Alan Chalmers. New York (11): Oxford Univ. Press; Oxford, Engl: Clarendon Press, 1949. Pp. 175. (Illustrated.) $3.75.

The appearance of a new book on atmospheric electricity is most welcome. The textbooks of Chauveau, Mache and Schweidler, Benndorf, Benndorf and Hess, *et al.*, are all more or less obsolete and for English readers only the short monograph of Schonland (1932) and three chapters in Fleming's *Terrestrial magnetism* (1939) by Gish, Torreson, and Schonland were available until now.

Chalmers' book is well written and up to date. One can immediately see that the author has worked a great deal (with Whipple) in this field.

It is especially commendable that the new ideas on the mean lifetime of ions and the equilibrium between small and large ions (Nolan, Whipple, Schweidler) are fully presented and that the thunderstorm phenomena are described in modern form, taking into account the results of the alticloctrograph recordings.

The author mentions in the preface that he purposely omitted a chapter on cosmic rays (as, for instance, given in Schonland's book) and I agree with him that a full presentation of these phenomena is not necessary for the explanation of atmospheric-electric phenomena. I wish, however, that the importance of ionization by cosmic rays had been stressed in the discussion of the ionization balance of the lower atmosphere, especially over the oceans. Also, I think, the treatment of the main problem of atmospheric electricity (maintenance of the earth's negative charge), although excellent, is perhaps incomplete, since the reader does not get any information with regard to the transfer of charges from the upper part of the thunderstorm regions to the ionosphere.

I also should have wished to see a quantitative treatment of the role of the various ionizing agencies in the atmosphere: contribution of the alpha, beta and gamma rays from the radioactive products in the atmosphere, their distribution with altitude (W. Schmidt's theory of mass exchange) and contribution of ionization by cosmic rays in the free atmosphere in the troposphere and the stratosphere.

In all other respects, Chalmers' book is a very fine, modern text, which deserves full recognition as a standard monograph and wide distribution among geophysicists and specialists in the field of atmospheric electricity.

VICTOR F. HESS

Fordham University

(*Continued from page 469.*)

Brucella organisms. Werner Braun (Camp Detrick) reported on the variation of *Brucella* and on a selective factor present in the serum of normal *Brucella*-susceptible species which is able to suppress the establishment of avirulent variants. This factor is absent from the serum of relatively insusceptible species, as well as from the serum of infected or vaccinated individuals of susceptible species. It is hoped to develop a new method of therapy based on the inactivation of this "SS" factor *in vivo*. In his discussion of the physiology of *Brucella*, B. H. Hoyer (National Institutes of Health) reported that the urease activity of *Br. abortus* strains is much lower than that of *Br. melitensis* or *Br. suis* strains, and that the urease test, used quantitatively, represents an additional aid in differentiating *Brucella* cultures. Sanford Elberg (University of California) discussed the relatively low resistance of large and small animals to reinfection with *Brucella* organisms, particularly in respect to tissue response, and the dissemination of the organisms in the internal organs of immune animals as compared with susceptible animals.

The evening session of the first day was devoted to a discussion of clinical problems and an evaluation of available chemotherapeutic materials. W. W. Spink (University of Minnesota) reported on his experience over a period of 12 years with over 250 culturally proved cases of brucellosis. He emphasized that an unequivocal diagnosis of brucellosis is established only when *Brucella* organisms are cultured from the tissues or body fluids. Positive agglutination tests are helpful in diagnosing the disease, although skin tests and opsonocytophagic tests are of only doubtful value. In his evaluation of the effectiveness of currently available chemotherapeutic agents, Wesley Eisele (University of Chicago) took the point of view that no satisfactory drug was yet available for the treatment of brucellosis and that many of the reported successes in therapy represented spontaneous recoveries. Dr. Eisele admitted that streptomycin plus sulfadiazine, aureomycin, and some other agents often, or usually, suppressed the disease, but considered that relapse of the infection could be anticipated with great frequency after treatment with such agents.

In opening the morning session of the second day, M. R. Irwin (University of Wisconsin) reported on the presence of bactericidins, particularly for *Br. abortus*, in the blood of experimentally infected or vaccinated cattle, as well as in some normal animals, these antibodies being distinct from agglutinins. A. I. Braude (University of Minnesota), in discussing the pathology of brucellosis, pointed out that the disease in experimental animals is characterized by the formation of granulomas in the tissues, by the development of hypersensitivity, and by the appearance of the *Brucella* organisms within the macrophages. The limitations and interpretations of the common laboratory tests used in diagnosing brucellosis were described by N. B. McCullough (University of Chicago and National Institutes of Health). The use of the guinea pig for chemotherapeutic tests was reported on by B. N. Carle (National Institutes of Health). F. M. Anderson (Federalsburg, Maryland) reviewed an outbreak of brucellosis in the small town of Federalsburg, Maryland, in closing the morning session.

The afternoon session of the second day was devoted to the epidemiology of brucellosis. C. F. Jordan (Tarrant County, Texas, Health Department) reported that, for the seven-year period 1940–1946, the average yearly aggregate of reported cases of brucellosis in the United States was at the rate of 3.11 per 100,000 population. *Br. abortus* infections predominate in areas devoted to dairying or cattle-raising, whereas *Br. suis* infections are most common in the meat-packing industry and in hog-raising areas. S. R. Damon (Indiana State Health Department) presented the results of studies on the epidemiology of brucellosis in Indiana, a much lower incidence of the infection being encountered than was considered probable when the study was initiated. P. Moralés Otero (Santurce, Puerto Rico) reported that brucellosis was first discovered in 1921 in Puerto Rico, and that, in the years since, the infection had become disseminated in cattle throughout the island. The incidence of the infection in man has increased correspondingly and is currently five times that reported in the island in 1930. During 1948, the Insular Government inaugurated a brucellosis eradication program in Puerto Rico. The incidence of brucellosis in Canada varies greatly among different provinces, according to R. Gwatkin (Canadian Department of Health). Steps are being taken by the Canadian Government to aid in the control of the disease among cattle and swine. R. Newton (Swift and Company) briefly outlined the problems which the meat-packing industry faces in brucellosis. In closing the meeting, C. M. Carpenter (University of California at Los Angeles) summarized his experiences in studying brucellosis over approximately twenty-five years, particularly in respect to the use and interpretation of skin test responses to *Brucella* antigen.

Association Affairs

THE DECEMBER MEETING

All arrangements for the 116th Meeting of the AAAS, December 26–31, are proceeding on schedule despite indications that this will be the largest annual convention in the 101-year history of the AAAS. All but one of the Association's 17 sections and subsections and nearly 60 participating societies will have programs—most of them with multiple sessions. The five Penn Zone hotels and the Manhattan Center (with some sessions on the campus of Columbia University) make it possible to maintain the integrity of each society's sessions and yet retain the advantages of a large diversified meeting in one compact area within a radius of three city blocks.

Ten symposia sponsored by the Association are for the most part grouped on Thursday and Friday, December 29 and 30. A summary of all the programs and a description of the 70 exhibits that fill the 85 booths—all that could be made available this year—will appear in the preconvention issue of *Science*, December 9, 1949. Advance registrants will receive the general program, of over 300 pages, the first week in December.

It would be impossible to make arrangements for the large and complex meetings of the AAAS, to ensure their smooth operation, and to secure adequate publicity for the programs and special events without the cooperation of a great many individuals and the generous contribution of their time and effort. This year, the 70-odd section and society secretaries (with few exceptions) were prompt in sending in their copy, including more than 2,000 titles; the printer of the general program has maintained a tight schedule for galley and page proof, and the AAAS local committees already have begun their substantial duties. A complete list of these committees follows:

General Chairman

Joseph W. Barker, president, Research Corporation.

Executive Committee

(Composed of the chairmen of the six local committees)
Joseph W. Barker, chairman; *George S. Avery, Jr.*; *Harold H. Clum*; *Stuart C. Dorman*; *Robert Harron*; *R. W. King*; *George B. Pegram.*

Advisory Committee

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The 116th Meeting of the AAAS, and the annual meeting for the year 1949, is also the sixth New York meeting. The previous occasions when the Association met in New York City were 1887, 1900, 1906, 1916 and 1928. It will be noted that an interval of 21 years has elapsed since the fifth New York meeting, when Henry Fairfield Osborn and Arthur A. Noyes were president and retiring president, respectively.

The organization of the meetings is much the same, a number of the exhibitors in the 1949 Annual Science Exposition were present in 1928, the roster of the participating societies retains many of the same names—and there will be a gratifying number at the sessions of 1949 that also were there 21 years ago. George B. Pegram, of Columbia, who was general chairman of local committees in 1928; Sam F. Trelease, who edited the program that year; and Donald E. Lancefield, then chairman of the special committee on local transportation, are all serving on the Local Advisory Committee this year. Edmund W. Sinnott, of the 1928 Local Committee on Exhibitions, is the 1949 retiring president of the Association, while Roger Adams, current president elect, was chairman of the AAAS Committee on Prize Awards at the fifth New York meeting. Once again, the Biologists' Smoker will be held at the American Museum of Natural History.

But there are differences. A whole generation of young scientists has reached maturity and increased the membership of the Association. This year's meeting is larger in participating organizations and includes new societies, the papers are more numerous, the attendance is greater, and there are more exhibitors. The greatest differences, however, are the advances that have been made in science itself, the technological innovations and their effects on man's thinking.

NEWS and Notes

George D. Stoddard, president of the University of Illinois, has been elected chairman of the U. S. National Commission for Unesco. Dr. Stoddard succeeds Milton S. Eisenhower, whose terms of office have reached the limit of three set by the bylaws.

Karl A. Folkers, director of organic and biochemical research for Merck and Company, Inc., will deliver the fifth annual Harrison Howe Lecture at a meeting of the Rochester Section of the American Chemical Society, November 7. Dr. Folkers will speak on "Research on Vitamin B_{12}."

Tze-Tuan Chen, formerly professor of zoology at the State Teachers College at Bemidji, Minnesota, has joined the Department of Zoology staff of the University of Southern California. Dr. Chen will continue his work on protozoan cytogenetics, which has been supported by a Public Health Service grant.

Alma P. Beaver, associate professor of psychology at Santa Barbara College of the University of California, will conduct a survey of educational and clinical methods in the Scandinavian countries from January to June, 1950. Dr. Beaver is on sabbatical leave from the university, and is now making a study of psychological theories and methods of therapy at the Langley Porter Clinic, San Francisco.

Clarence F. Winchester, formerly associate professor of nutrition at the University of Florida, is now physiologist at the Animal Husbandry Division, U. S. Department of Agriculture Research Center, Beltsville, Maryland. Dr. Winchester is in charge of research projects relating endocrinology to problems of nutrition.

Elizabeth A. Lockwood has been appointed as field consultant in health education by the National Foundation for Infantile Paralysis. She will advise professional groups and state representatives of the foundation in the development of health education programs relating to poliomyelitis.

George Howard Parker, professor emeritus of zoology, Harvard University, has been made patron of the Bermuda Biological Station for Research by election of the station's board of trustees.

James F. Kerwin, research chemist, has been named assistant head of the Organic Chemistry Section of Smith, Kline and French Laboratories in Philadelphia.

Visitors to U. S.

Pandit Jawaharlal Nehru, Indian prime minister, and his sister, ambassador to the U. S., conferred in Boston last week with James B. Conant and Harlow Shapley, of Harvard University, about a new Schmidt-type telescope for the Allahabad University Observatory in north India, and a sun-observing coronagraph for Mt. Kodaikanal Solar Observatory in southern India. **A. C. Banerji**, of Allahabad, and **A. K. Das**, of Mt. Kodaikanal, will visit Harvard later to work out the details of the project.

Sven Hellerstrom, professor and chief of the Dermatologic and Venereal Disease Clinic of the University of Stockholm, lectured last week at the New York University-Bellevue Medical Center.

Felisberto Pinto Monteiro, of Rio de Janeiro, is in this country for research in the field of fish and wildlife. Mr. Pinto has received a three months' grant-in-aid from the U. S. Department of State.

Recent visitors at the National Bureau of Standards included: **D. J. Badkas**, assistant professor, Indian Institute of Science, Bangalore, India; **D. H. Black**, director, Telecommunications Research and Development, Ministry of Supply, England; **E. Heymann**, associate professor of physical chemistry, University of Melbourne, Australia; **L. E. Howlett**, associate director, Division of Physics, National Research Council, Ottawa, Canada; **J. S. McPetrie**, superintendent of research, Signals Research and Development Establishment, England; **C. Pot**, general director, Electro-Smit Dynamoworks, Slikkerveer, Holland; **H. N. Ramachandra Rao**, assistant professor, Department of Power Engineering and Electrical Technology, Indian Institute of Science, Bangalore; **Yves Rocard**, chef du Service des Recherches, Direction Centrale des Constructions et Armes Navales, Paris, France; **T. Edward Allibone**, director, Associated Electrical Industries, Ltd., Research Laboratories, Aldermaston, Berkshire, England; **Lucien Biguet**, director, Department of Chemical Products, S. A. Coframet, Paris; **Luis Bramao**, chief, Department of Soils, Portugal; **A. J. Dale**, director of research, Johnson Brothers, Ltd., Stoke-on-Trent, England; and **M. A. Malik**, electrical engineer, Public Works Department, Lahore, Pakistan.

Grants and Awards

The Board of Foreign Scholarships of the State Department has announced the teaching and research awards made for this academic year under the terms of the Fulbright Act. Among the American exchange scholars are: *Bernard Freeman Mann*, resident in pathology, New England Deaconess Hospital, Boston, selected as visiting lecturer in pathology at University of the Philippines; *Fred Eggan*, professor and chairman of the Department of Anthropology, University of Chicago, for anthropological research in the Philippines; *Pauline Fertsch*, assistant professor of psychology, University of Texas, visiting lecturer in psychology at the University of the Philippines; *Ruth M. Leverton*, director of human nutrition and food research, Department of Home Economics, University of Nebraska, to teach nutrition at the Philippine Women's University; *Jesse E. Thompson*, chief resident surgeon, Massachusetts Memorial Hospital, Boston, for research in medicine at Nuffield Medical Research Institute, Oxford University; *Robert L. Driver*, interne, Hospital of the University of Pennsylvania, for research in neuropharmacology and neurophysiology, University of Edinburgh, Scotland; *Randolph W. Chapman*, professor of petrography, Johns Hopkins University, visiting lecturer in geology, St. Andrews University, Scotland; *Elmer B. Tolsted, Jr.*, assistant professor of mathematics, Pomona College, visiting lecturer in mathematics at University College of the Southwest, Exeter, England; *Roger W. Russell*, associate professor of psychology and resident fellow in neurophysiology at University of Pittsburgh and Western State Psychiatric Institute, for research in animal psychology at the Institute of Psychiatry, University of London; *Elwood C. Zimmerman*, associate entomologist, experiment station of the Hawaiian Sugar Planters Association, for research on insects of Hawaii at the British Museum of Natural History; *Darragh E. Nagle*, instructor in physics, Massachusetts Institute of Technology, for research in nuclear physics, Cambridge University; *David E. Schneider*, teaching fellow, Department of Social Relations, Harvard University, lecturer in anthropology, London School of Economics; *Sewell Wright*, professor of zoology, University of Chicago, visiting lecturer in statistical genetics, University of Edinburgh; *Josef F. Bunnett*, assistant professor of chemistry, Reed College, Portland, Oregon, for research in theoretical organic chemistry, University College, London; *Ernest Sachs, Jr.*, senior fellow in neurosurgery, Yale University, research in lobotomy, National Hospital, University of London; *Clyde Stormont*, assistant professor of genetics, University of Wisconsin, for research in dairy science at the Animal Research Station, Wallaceville, New Zealand; *Basil E. Montgomery*, associate professor of entomology, Purdue University, Lafayette, Indiana, for research in the ecology of the bumble bee in relation to the fertilization of red clover, University of New Zealand, Aukland; *William R. Vance*, assistant professor of natural science, Chico State College, Chico, California, visiting professor of public health, University of Rangoon, Burma; *C. Donnell Turner*, chairman, Department of Biology, Utica College of Syracuse University, visiting professor of biology, University of Rangoon; *Roy G. Bose*, professor of psychology, City College, Santa Monica, California, visiting lecturer in child guidance, Philippine Normal School, Manila; *William J. Emerson*, medical investigator, Massachusetts General Hospital, Boston, for research on medicine, University of Paris; *Edgar Bright Wilson, Jr.*, professor of chemistry, Harvard University, for research in chemistry, Queens College, Oxford University; *John Richard King*, postdoctoral student at Harvard University, visiting professor in agriculture, State Training College for Teachers, Rangoon; *Kerro Knox*, research fellow, Brookhaven National Laboratory, for research in chemistry in the Department of Physical Chemistry, Cambridge University; *Edward M. Corson*, senior physicist, Armour Research Foundation, Illinois Institute of Technology, Chicago, for research in physics, Edinburgh University; *John W. Swensson*, formerly physicist at University of California Radiation Laboratory, for research in physics, University of Liège, Belgium; *Harry H. Turney-High*, professor and head of the Department of Anthropology and Sociology, University of South Carolina, Columbia, for research in sociology at University of Liège; *Peter Van de Kamp*, professor of astronomy, Swarthmore College, director of Sproul Observatory, visiting lecturer in astronomy, Institut d'Astrophysique, Paris; *Horace M. Miner*, associate professor of anthropology and sociology, University of Michigan, for research in sociology, University of Algiers, Algeria; *Nathan James Smith*, research fellow in hematology, Children's Hospital, Boston, for research in medicine, University of Paris; *Guy W. Adriance*, head of the Department of Horticulture, Agricultural and Mining College of Texas, College Station, Texas, for research in horticulture, Italy; and *Howard W. Etzel*, research physicist, Carnegie Institute of Technology, Pittsburgh, for research in physics at the Laboratoire de Physique, University of Paris.

The J. Lawrence Smith Medal of the National Academy of Sciences has been awarded to Fred Lawrence Whipple, chairman of the Department of Astronomy of the Harvard Observatory. Dr. Whipple received the award in recognition of his research in the field of the motions and nature of meteoric particles in the earth's atmosphere, and especially for his derivation of the variations of air temperature with altitude, based on his studies of meteors.

Fellowship

Approximately 600 U. S. Government awards for foreign study are available from the Department of State for graduate study or research during the academic year 1950–51. The countries with which this educational exchange program is now in effect are Belgium and Luxembourg, Burma, France, Greece, Iran, Italy, Netherlands, New Zealand, Norway, the Philippines, and the United Kingdom. Closing date of these competitions is *December 1*. The awards, made available through the Fulbright Act, provide tuition, transportation, and maintenance for one academic year. Candidates for student awards must be American citizens, and must have a college degree or its equivalent, as well as a knowledge of the language of the country in which they intend to study. They should apply to the Institute of International Education, 2 West 45th Street, New York City 19. Candidates at the postdoctorate level, or those not having a doctorate but of recognized professional standing, who propose to teach or carry out an independent program of research abroad, should apply to the Conference Board of Associated Research Councils, 2101 Constitution Avenue, Washington 25, D. C.

Colleges and Universities

University of Michigan scientists have recently obtained samples of the earth's atmosphere at a height well over 40 miles by the use of V-2 and Aerobee rockets. The research is being done by the Department of Aeronautical Engineering as a part of the U. S. Army Signal Corps program of investigation of meteorological phenomena at high altitudes. The project, which is under the direction of Leslie M. Jones, of the university's Engineering Research Institute, is particularly concerned at present with the concentration of helium at the earth's surface and in the upper atmosphere. Preliminary analysis of the samples indicates that the atmosphere up to 230,000 feet has the same relative proportions of gases as at ground level. The gas analysis was done by F. A. Paneth of Durham University, England, who has been investigating the concentration of helium in the atmosphere on a world-wide basis. Results of this research will eventually be used in studies of rocket design and weather.

The University of Wisconsin opened its new Enzyme Institute on November 1, under the direction of David E. Green. The Atomic Energy Commission and the U. S. Chemical Corporation will collaborate with the institute in certain phases of research, and have allocated $30,000 and $20,000, respectively, to the project. The university's Alumni Research Foundation built the $350,000 laboratory and staff salaries are paid by the university.

Meetings and Elections

The Fifth General Assembly of the International Council of Scientific Unions was held in Copenhagen, September 14–16, at the Royal Danish Academy. In welcoming the delegates, the president of the academy spoke of the great value of close cooperation among scientists of different nations and of the need in days of rapidly increasing control of the forces of nature to override the limits imposed by national boundaries.

The main business of the meeting was to consider a revision of the statutes to meet the change of conditions since they were drawn up in 1931. The two chief alterations agreed upon were the formation of a bureau within the executive board, and a classification of the unions into two groups, general and specialized. Of the existing unions the following were classed as general: astronomy, geodesy and geophysics, chemistry, physics, and biology. The remaining unions—radio sciences, geography, crystallography, mechanics, and history of sciences—were classed as specialized. No new unions were accepted as adhering organizations but the bureau was instructed to appoint a policy committee to examine and report upon the principles which should govern the admission of new unions. Some anxiety was shown regarding a resolution adopted by the Executive Board of Unesco recommending that grants-in-aid should be made principally to new projects, but it was decided at the General Conference of Unesco, which followed almost immediately after the General Assembly of ICSU, to continue the grants-in-aid which had given most useful and valuable help to Unesco and its unions.

The following were elected as the bureau for the next three years: president, A. von Muralt, Switzerland; vice presidents, E. Borel, France, and H. Solberg, Norway; members, D. J. N. Mukherjee, India, and E. Herbays, Belgium; immediate past president, John A. Fleming, U. S.; general secretary, F. J. M. Stratton, Great Britain.

F. J. M. STRATTON

The National Malaria Society will meet conjointly with the **American Society of Tropical Medicine**

and the **American Academy of Tropical Medicine** at the Hotel Peabody, Memphis, Tennessee, November 6–9. The National Malaria Society has scheduled three scientific sessions, including a joint meeting with the American Society of Tropical Medicine.

A symposium on dynamic properties of polymeric materials, sponsored by the Institute of Polymer Research, will be held November 19 at the Polytechnic Institute of Brooklyn. W. J. Hamburger, H. M. Morgan, and M. M. Platt, of Fabric Research Laboratories, Boston, will speak on "Mechanics of Ballistic Performance of Textile Materials"; A. V. Tobolsky, of Princeton University, on "Relations Between Dynamic and Static Properties of Polymers"; G. M. Kavanaugh and A. G. H. Dietz, of Massachusetts Institute of Technology, on "Ultrasonic Determination of Mechanical Properties of Synthetic Resin Adhesives"; and T. W. George, of the Naval Research Laboratory, Washington, D. C., on "Dynamic Localization of Plastic Flow."

New York University, in cooperation with the Atomic Energy Commission, will hold a three-day **conference on industrial and safety problems of nuclear technology**, January 10–12. Speakers include Gordon Dean, AEC commissioner, W. E. Kelley, manager of the New York Operations Office of AEC, G. K. Green, chief of the Accelerator Project at Brookhaven National Laboratory, Serge A. Korff, professor of physics at New York University, and G. Failla, professor of radiology, Columbia University.

The 18th International Physiological Congress will be held at Copenhagen August 15–18, 1950. Preliminary programs and registration forms will be sent out at the end of this year and will be obtainable, after January 1, from local societies of physiology, biochemistry, and pharmacology, or from the bureau of the congress, Zoofysiologisk Laboratorium, 32 Juliane Mariesvej, Copenhagen O.

The **annual meeting of the Scandinavian Pharmacological Society** will take place in Copenhagen, August 19–20, 1950. Members of pharmacological societies outside Scandinavia will be invited to attend this meeting.

Deaths

Charles F. Briscoe, 80, formerly head of the Department of Bacteriology at Mississippi State College, died on October 9. Dr. Briscoe was well known for his research on tuberculosis of farm animals and the response of soybeans to artificial inoculation.

Carl E. Seashore, 83, psychologist and dean emeritus of the Graduate School, University of Iowa, died October 16 in Lewiston, Idaho. Dr. Seashore, a native of Sweden, devised intelligence tests that were used by the U. S. Army during the first and second world wars. He was also known for his experimental work in the analysis and development of musical sound.

Raymond B. Wilcox, 60, pathologist at the U. S. Department of Agriculture station at Pemberton, New Jersey, died October 22 of a heart attack. Dr. Wilcox did research in diseases of small fruits and virus diseases of plants.

A National Foundation for Eye Research was recently formed in Washington, D. C., to encourage public support for research aimed at discovering the causes of ocular diseases leading to blindness, and developing more efficacious remedies. The activities of the foundation will be limited entirely to supporting and establishing research centers for ophthalmology, leaving other aid to the blind to existing agencies. George Swartz has been selected as national chairman. Allocation of research funds will be made upon the advice of a scientific advisory board consisting of V. Everett Kinsey, chairman, Francis Heed Adler, Edwin B. Dunphy, Jonas Friedenwald, and Alan C. Woods. Several more members will be added to the board as the need for expansion arises.

The Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, has submitted the following list of wanted chemicals: usneol, divaricatic acid, atranorin, shikimic acid, obtusatic acid, physodic acid, 1,2,4-trimethyl-3-hydroxyphenazine, berberine, 2,6-dinitro-4-hydroxylaminotoluene, senecioic acid, 2-4-diamino-6-methylpyrimidine, 2,3-dimercaptopropyl ethyl ether, butyl fluoride, azomethane, decafluorocyclopentane, carnegine, 2,3-dimercaptobutane, isobutyl peroxide, 4-amino-8-nitroquinoline, 2-methyl-8-hydroxyquinoline, apigenin, apiin, and canadine.

Bibliography of Books and Published Reports on Gas Turbines, Jet Propulsion, and Rocket Power Plants, Circular 482, by Ernest F. Fiock, has been published by the National Bureau of Standards and is now available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at 20 cents per copy.

Make Plans for—

Gulf and Caribbean Fisheries Institute, second annual meeting, November 15–18, Robert Richter Hotel, Miami Beach, Florida.

American Institute of Chemical Engineers, New York Section, November 17, Hotel Statler, New York City.

American Society for Pharmacology and Experimental Therapeutics, first interim meeting, November 17–19, Indiana University Medical Center, Indianapolis.

American Physical Society, 295th meeting, November 25–26, University of Chicago.

Central Association of Science and Mathematics Teachers, November 25–26, Edgewater Beach Hotel, Chicago.

National Council of Geography Teachers, 35th annual meeting, November 25–26, Hotel Cleveland, Cleveland.

American Mathematical Society, November 25–26, Illinois Institute of Technology, Chicago; November 26, California Institute of Technology, Pasadena.

Psychology and Scientific Research. II. Scientific Inquiry and Scientific Method

Hadley Cantril, Adelbert Ames, Jr., Albert H. Hastorf, and William H. Ittelson

Princeton University, Princeton, New Jersey,
Hanover Institute, Hanover, New Hampshire, and
Dartmouth College, Hanover, New Hampshire

WE HAVE HAD TO DISCUSS the nature of and the apparent reason for scientific inquiry because "scientific research" has so often been thought of merely as a technique or method of investigation. What we know as the scientific method is a means for pursuing scientific inquiry. If we do not bear this in mind, real progress in scientific research is apt to be thwarted. For the implicit equating of scientific inquiry and scientific method to a technique of investigation leaves out an all-important consideration: the problem of formulating a problem for scientific investigation. For the formulation of the problem for investigation must contain within itself the possibility of going beyond what is now scientifically established if it is to satisfy the definition of scientific research. If the formulation of the problem does not do this, then succeeding steps in investigation are futile.

Although there is likely to be little argument here, some "research" in psychology seems to reflect only a lip service to this fundamental tenet. It may be appropriate to underscore the point here in the words of modern scientists. Whitehead has pointed out that "no systematic thought has made progress apart from some adequately general working hypothesis, adapted to its special topic. Such an hypothesis directs observation, and decides upon the mutual relevance of various types of evidence. In short, it prescribes method" (*12*, 286). Einstein and Infeld have written that "the formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and makes a real advance in science" (*5*, 95). Oppenheimer indicates that the experimental techniques of science enable us to define and detect our "errors of conception" (*9*, 22).

It should be emphasized that if an hypothesis is to be regarded as adequate it must be more than a statement or description of current data and more than a prediction that data will reproduce themselves. An hypothesis must be tested both in terms of its ability to predict immediate events and its promise of leading to further, more adequate hypotheses. For in scientific procedure there is a never ending process of hypothesizing, a constant flow of one hypothesis from another, with each hypothesis trying to go beyond established formulations in its inclusiveness.[1]

It is the way in which the investigator poses his problem that determines where he will come out—what functional activities he will feel have a bearing on the problem, which of these he will use as the bases for standards in empirical investigation, and what methodological procedures he will follow or try to devise. In this connection it is relevant to note that the popular conception of what makes a scientist "great" is that he has solved problems that have long baffled others. While this may be true enough, a review of the history of science will show that in general the solution of a problem is relatively easy once the problem has been posed and that the real scientific contribution of those scientists we now regard as outstanding is due to the way in which they have formulated problems which they or others have solved. The tremendous advances in the physical sciences since the 17th century, for example, are due more to improved formulations than to changes in methodology. In the 17th century and continuing into the 20th, science sought all-inclusive "laws" and felt that reality was firmly in hand. But today both all-inclusive laws and reality seem more elusive than ever. Contemporary physics is seeing its ultimate particle disappear, physiology is realizing that it is not dealing with the classical closed energy system. The need for a basic conceptual reformulation to bring about newer and greater understanding is apparent on all sides. In his history of science, Dampier-Whetham has noted that "insight, imagination, and perhaps genius, are required firstly to pick out the best fundamental concepts" (*2*, 457).

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[1] In a memorandum concerning the conceptualization of novel problems, Horace Fries has called attention to the necessity of making a distinction between an increase in our understanding and the solution of an immediate problem. He points out that "the degree of success in the resolution of the difficulty is always relative, i.e., better or worse relative to the interests or desires affected. But the *solution* of a problem brings about an adequate *resolution* of the difficulty in proportion to the adequacy in which the difficulty is organized into a problem, i.e., the adequacy of the problemization of the difficulty" (*6*).

Search versus research. Much that now passes for scientific research, not only in psychology but in many fields, has precious little to do with what may be honestly called scientific pursuit. But the surface similarity between much current work and real scientific investigation may be sufficient to deceive the investigator himself. If investigators are not to hoodwink themselves and each other and pervert scientific inquiry for some end that has little if anything to do with increasing our understanding of man, it is clearly imperative that they be concerned as consciously as possible with research that will bring about major reformulations. Otherwise they are forced to close their eyes to important problems that face them or to devote themselves only to methodological problems, rationalizing these activities as research.

One variety of this perversion is represented in the shotgun approach, in which the idea seems to be that if one only gathers enough data, possibly with the use of new gadgets or apparatus, one must sooner or later come out with some sort of scientific result. A precedent for this type of activity was set by Francis Bacon who held that "by recording and tabulating all possible observations and experiments, the relations would emerge almost automatically" (*3*, 58). And in the three hundred years since Bacon's time, many investigators have proceeded either without any clear hypothesis or with what they call "limited hypotheses," often so limited that they cannot possibly provide a springboard for further emergence. Much of such data today is concerned with correlational relationships. The situation is such that to an outside observer reviewing the history of modern thought, psychology seems to be merely "trying correlation after correlation in the hope of stumbling on something significant" (*11*, 495).

Another perversion of scientific method is found in the tendency in some areas of psychology to work out elaborate classifications, with the implication that if the behavior of an individual can only be properly pigeonholed in some static system, then further analysis of a functional nature is relatively unimportant for understanding. Karl Pearson's emphasis on classification as a major pursuit of science undoubtedly did a great deal to establish this misconception. One needs only to review the literature in the field of personality or to watch many clinicians diagnose psychiatric patients to see how some men in these areas are struggling to free themselves from older classificatory systems.

Scientific inquiry and scientific method are also not to be confused with investigations limited solely to a so-called "quantitative approach." An overconcentration on problems of measurement as such can easily sidetrack the investigator from the more important concentration on what data are significant to gather and can blind him completely to the problem of problemization, with its concurrent problem of selecting the standards worth measuring. Furthermore, those who are wedded solely to a quantitative approach are all too frequently unwilling to tackle problems for which there are no available quantitative techniques, thus limiting themselves to research impressive only in the elaborate quantitative treatment of data. Current attempts to refine sampling techniques in the field of public opinion research, for example, while indispensable, run the danger of making investigators myopic to certain areas of inquiry that would seem much more important for an understanding or prediction of public behavior—for example, the problem of asking the right questions, of determining the surety of opinion under different circumstances, or the effect of different interviewing situations on response. The current vogue of factor analysis in the study of personality, while most significant as a means of testing a theory as Eysenck's report shows (*6*), frequently reflects insufficient consideration of the relevance or adequacy of the variables thrown into the hopper for analysis.

The function of experimentation and measurement. In saying that what now passes for research (scientific inquiry instrumented by scientific method) is often only scientific pretension, we do not mean to imply at all that reasonable problems for scientific research can be formulated or operated on without including empirical investigation. Experimentation is clearly indispensable as a test of formulation. An hypothesis can be tested only if one is able to do something with it. But it is often forgotten that the value of an experiment is directly proportional to the degree to which it aids the investigator in formulating better problems. And while a single experiment may solve a problem, it can never give us complete understanding. If an investigator believes that by solving a problem he has achieved complete understanding it only shows that his problem has been defined inadequately and is not a step in the constant, never ending scientific search for more and more comprehensive formulations.

The importance of any scientific experiment in which relevant variables are manipulated must be in terms of the breadth of the formulation it has a bearing on. It should be borne in mind that the first and most significant step in experimentation is to determine *if* the variation of one abstracted phenomenon affects other abstracted phenomena at all. The next most disclosing step is to determine *how* the variation of one abstracted phenomenon affects other abstracted phenomena. We confirm or deny the validity of an hypothesis by determining if and how the manipulation of one variable affects another variable or the total group of phenomena in which we are interested. In the process of using the scientific method of relevant variables, the investigator can discover if and how variables are affected only with reference to some inclusive, higher-order formulation. Otherwise relevant variables could be manipulated forever without making any scientific advance at all. It is also imperative to bear in mind that how much a change in one variable affects another variable does not give us new insight on the "if" and "how" relationship. We determine how much one variable affects another in order to increase our prediction and control, not to increase our range of understanding.

In the process of experimentation, the investigator must be ready to use whatever procedures appear most relevant to an understanding of the problem at hand. These procedures will be both quantitative and nonquantitative. Obviously if we select some phenomenon or characteristic as a variable for experimentation we can do so only because it exists in some degree, some amount, some quantity in relation to the abstracted standard upon which it is based. In scientific research quantitative and nonquantitative procedures are interdependent, and highly refined quantitative investigation may be necessary before one can establish a nonquantitative formulation as, for example, the relationship between the Michelson-Morley experiment and Einstein's formulation. Thus the establishment of any dichotomy between quantitative and nonquantitative procedure is an artificial barrier to scientific progress, separating and taking apart what really belong together in scientific method. Scientific inquiry will be strapped if the investigator feels that he cannot be scientific without being one hundred percent quantitative.

Because scientific methodology is now so often equated solely with quantitative procedures, it may be useful here to distinguish what seem to us to be the function of quantitative procedures in scientific method.

First is the design of controlled experiments or other systematic investigations which involve measurement for the specific purpose of checking a hunch, validating an hypothesis, or testing a general law in a specific concrete situation. As we have already emphasized, the verification of this hypothesis is itself to be regarded only as a stepping stone to further, more inclusive hypotheses. In the fields of psychology and the social sciences, this general function usually translates itself into the purpose of checking some experienced relationships and causalities in an effort to intellectualize and systematize hunches that seem significant.

A second role played by quantitative measurement is the systematic recording of data. But it must be emphasized again in this connection that the accumulation of quantitative results is profitable only to the extent that some previous intellectual excursions have led to an hypothesis which is subjectively held with some degree of surety. Recording without an hypothesis in mind, if it is indeed possible at all, has no place in scientific method.[2]

A third function of quantitative research is to establish norms for the purpose of studying single cases—in psychology, for example, individual or group variations. As any experimental, clinical, or social psychologist knows, quantitative standards are of the utmost importance in predicting how specific individuals or groups of individuals will react in specific situations. But again it must be borne in mind that one undertakes measurement for such purposes only after the formulation of some hunch which may itself be based on nonquantitative evidence. And we must furthermore remember that we can only measure something relative to an arbitrarily established norm.

Whereas most investigators would undoubtedly give a nod of approval to the thesis that quantitative and nonquantitative procedures are interdependent in scientific method, much current work in psychology and the social sciences indicates that in practice this kind of thinking and research-planning is not followed, and that, on the contrary, there is often a conscious or unconscious attempt to imitate the physical scientists, in the false belief that their success has been due chiefly to the quantitative techniques they have designed. It may therefore be worth a brief historical glance at Isaac Newton's procedure to gain some perspective on the role of quantitative experimentation in verifying and extending nonquantitative observations.

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[2] Occasionally Charles Darwin's work has been used as an illustration of the way in which an hypothesis suddenly appears if one can only accumulate sufficient data. But in the famous first paragraph of his introduction to the *Origin of species* (1859), Darwin clearly belies any such contention.

> When on board H.M.S. "Beagle" as naturalist, I was much struck with certain facts in the distribution of the organic beings inhabiting South America, and in the geological relations of the present to the past inhabitants of that continent. These facts, as will be seen in the latter chapters of this volume, seemed to throw some light on the origin of species—that mystery of mysteries, as it has been called by one of our greatest philosophers. On my return home, it occurred to me, in 1837, that something might perhaps be made out of this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing on it. After five years' work I allowed myself to speculate on the subject, and drew up some short notes; these I enlarged in 1844 into a sketch of the conclusions, which then seemed to me probable: from that period to the present day I have steadily pursued the same object. I hope that I may be excused for entering on these personal details, as I give them to show that I have not been hasty in coming to a decision.

And we find in Darwin's letter this further statement (4, 183):

> In October 1838, that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement Malthus on population, and, being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. The result of this would be the formation of new species. Here then I had at last got a theory by which to work.

Although Newtonian concepts have been superseded, the Newtonian method remains essentially unchanged and still provides the framework for most of modern science. While Newton's aim was to find absolute, mathematical "laws of nature," his method clearly consisted of (1) simplification and isolation of fundamental concepts, (2) formulation of relevant hypotheses on the basis of these essentially nonquantitative concepts, and (3) intensive quantitative verification and amplification of these hypotheses. Although the concepts of mass and the mutual attraction of gravitation are inherent in a falling apple, it is doubtful if they would ever emerge from a statistical study of *all* falling objects on the face of the globe. As Newton expressed it, "Our purpose is only . . . to apply what we discover in some simple cases, as principles, by which . . . we may estimate the effects thereof in more involved cases." The inverse of this, the attempt to find the "principles" in the welter of "involved cases," would have seemed senseless to Newton.

In developing his methodology, which he nowhere explicitly defines, Newton was in effect systematizing what had become over the centuries the *de facto* method of the "natural philosophers." Nineteen hundred years before Newton, there was sufficient evidence for Aristarchus to advance his heliocentric concept of the universe. This significant concept was, of course, lost until Copernicus, reading the ancients, discovered that some philosophers had "thought the earth was moved." "When for this reason, therefore, I had conceived its possibility, I myself also began to meditate upon the mobility of the earth." The immediate result of this fruitful hypothesis was, of course, a systematic theory which, however, still depended for its acceptance on the principle of mathematical simplicity. Galileo, sensing the importance of experimental verification, provided the last historic step by means of his telescope.

The Newtonian era probably represents one of the most significant and fruitful epochs in human thought. Relevant to our discussion here, the birth of scientific inquiry was accompanied by a formulation of concepts which have determined and dominated thinking up to the present day. Copernicus meditated "upon the mobility of the earth." Newton, age 23, "began to think of gravity extending to ye orb of the Moon." Kepler gave support to the Copernican system because "I have attested it as true in my deepest soul," and "I contemplate its beauty with incredible and ravishing delight." Harvey "began to think whether there might not be a motion [of the blood], as it were, in a circle." Huygens and others formulated the principle of the conservation of what later was termed kinetic energy. The list is virtually endless. In every area of human thought startling and productive contributions were made. Since there is no reason to suppose that the 17th century was especially propitious for the birth of genius, one wonders if the productivity of this period may not be attributed to a fortunate blending of *unfettered speculation* coupled with a new awareness of the need for empirical verification at every step. Remove the speculation and only barren measurement remains.

Operationism. In the past quarter-century the basic tenets of operationism have so interested all science and have become so ingrained in the thinking of most scientific investigators that no discussion of the role of experimentation in scientific inquiry can be complete without a consideration of the place of operationism which is, historically, a "recent formulation of some of the essential features of the experimental method and of empiricism generally" (*7*, 250).

The impetus for operationism came from Bridgman in physics with the recognition that concepts such as distance have different meanings when used in different contexts. The concept is, therefore, a construct of the observer and not "a thing in itself." It follows that if the variables with which an experimenter deals are products of the experimenter's ingenuity and cannot be specified by pointing to them, then they must be specified by pointing to the procedures employed by the experimenter in creating his constructs. It is only by pointing out the procedures employed in experimentation that the investigator can convey to others the constructs he is dealing with.

Unfortunately, however, the generality of Bridgman's approach has sometimes been lost sight of. There is nothing in the general statement of operationism which delimits or in any way prescribes the defining operation to be used. Bridgman himself has asserted that "any method of describing the conditions is permissible which leads to a characterization precise enough for the purpose in hand, making possible the recovery of the conditions to the necessary degree of approximation" (*1*, 246). Those writers who assert that defining operations must necessarily be "physicalistic" are gratuitously adding a restriction not inherent in the operational approach. This insistence probably trace back to the feeling that physicalistic constructs are somehow more "real" than others and has led to a fundamental misconception and perversion of the operational approach as originally stated.

The inhibiting effect of this artifical restriction has probably not been severe in those sciences more closely concerned with the physicalistic. In psychology, however, this has tended to exclude the use of psychological constructs and, as Pratt has stated, "to place a stamp of approval on certain limited fields of research in which hypotheses can be neatly formulated in the language of the older sciences" (*10*, 268). We have indicated that a study of relationships alone does not constitute scientific research. Real research must always involve constantly higher-order abstractions. In the field of psychology many of these abstractions cannot possibly be "pointed to" in any narrow operational sense and many of them are not easy to manipulate experimentally. While a scientific investigator must rely upon operational concepts, he must remember at the same time, as Feigl has said, that "operationism is not a system of philosophy. It is not a technique for the formation of concepts or theories. It will *not by itself* produce scientific results. These are brought about by the labor and ingenuity of the researchers" (*7*, 258).

Selection of standards. A major problem confronting any investigator is the selection or discovery of the standards to use in his investigation. The dictionary defines a standard as "that which is set up and established by authority as a rule for the measures of quantity, weight, extent, value, or quality."

The problem of selecting standards is much more complicated than is often realized, for the reason that the conditional relationships we abstract out of a total situation and except for which the situation would not exist do not themselves exist in their own right. Nor is there any adequate intellectual explanation of their existence. These conditional relationships or aspects of a total phenomenon that the scientist calls "variables" are not God-given and are not limited. Einstein and Infeld point out that "physical concepts are free creations of the human mind, and are not, however it may seem, uniquely determined by the external world" (*5*, 33). Any adjective or any adverb can serve as a potential basis for a variable. Variables that provide the bases for standards are purely the creations of man, enabling him to formulate an abstract, common, determined phenomenal world. The variables employed in any scientific research are based on intuitive judgments and in any concrete investigation depend upon the way in which the investigator has formulated his problem. Since problems are formulated differently in different fields of inquiry, the aspect of a phenomenon that we choose in one field to serve as the basis for a standard in that field will not necessarily be applicable in another field of inquiry. Furthermore, the aspect of a phenomenon that may serve as a basis for standards within any one field will vary according to the nature of the hitch in a concrete situation.

Here words play their familiar tricks even with the thinking of the scientist, who may tend to forget that in his necessary use of word symbols for his thinking and communication (*space, time, I.Q., attitude,* etc.) he is employing abstractions which he cannot, as a scientist, implicitly or unconsciously assume as real in investigation. And it is only to the extent that the investigator is aware of his own transformation of adjectival or adverbial relationships into noun qualities that he maintains the possibility of discovering new conditional relationships except for which a phenomenon would not exist. If abstracted characteristics of the situation are unconsciously reified, complacency or a defensive attitude results.

When we decide on a standard, we take some aspect of a phenomenon, some variable, as a basis for measurement. Since the phenomena with which science deals are so enormously varied, the quantitative units employed in any investigation will depend on the nature of the problem at hand—e.g., distance will be measured in angstrom units or in light years. Also, obviously, we cannot necessarily quantify one standard in the same way we do other standards. While precise units of measurement may be applicable in the physical sciences, in psychology, if we are using some aspect of experience as the basis for a standard, we may have to be satisfied with crude introspective measures such as "more than" or "less than." Whitehead has pointed out that "we must entirely separate psychological time, space, external perception, and bodily feeling from the scientific world of molecular interaction. This strange world of science dwells apart like the gods of Epicurus, except that it has the peculiar property of inducing our minds to play upon us the familiar antics of the senses" (*13*, 62).

Since every standard is based on a man-made assumption, and since it is possible for man to use an infinite number of abstracted subphenomena as bases for standards, the criterion for the selection of what shall be used as the basis for a standard is essentially its usefulness in determining whether or not the abstracted subphenomenon with which we are dealing is constant, verifiable, and potentially helpful in solving our original problem. Also, of course, the basis to be used for our standard must be subject to voluntary recall and to intellectual manipulation.

How do we proceed to select the standards we will use in actual empirical investigation? Since we must start with the nature of the particular hitch we have experienced, abstract generalizations or rules cannot be given. The best that can be done is to describe the apparent functional process that goes on.

It seems to be something like this: In the course of following an acquired interest in understanding why certain phenomena occur (in physics, biology, psychology, and other sciences) we encounter a difficulty which no previous investigator has resolved to our intellectual satisfaction or perhaps has faced as we face it now. The assumptive world we have built up from experience (which includes the abstracted scientific concepts that have a bearing on the problem) proves inadequate as we try to intellectualize the hitch we have run into. There is no empirical evidence we can find that describes all the conditions except for which the phenomenon that puzzles us would not exist.

In trying to intellectualize the inadequacy of our assumptive world, we discover that a certain condition or set of conditions have not been taken into account. We abstract out of the hitch-situation those aspects we believe are probably necessary to our understanding of the original hitch. We use these aspects of a phenomenon as the bases for our standards, and we vary their "amount." We may have an understanding of why such conditions are important at the time we think of them or we may only have a vague hunch that they are important and may intellectualize them much later. If we have an immediate understanding, we can design our investigation rather precisely. If we have only a hunch, a certain amount of trial and error in experimentation is necessary. But this trial and error takes place within boundaries we set and is not to be mistaken for a shotgun approach. In either case, we design the empirical test of our new basis for a standard with reference to other phenomena that have already been established as bases for standards. We do this in an attempt to determine whether or not the variation in the new basis we have selected for a standard affects old standards and is affected by them according to our formulation.

Our formulation may be validated in some circumstances if the new aspect of the phenomenon we have introduced is affected by other functional aspects. Or, under other circumstances, our formulation may be confirmed if the new aspect we have introduced is not affected by other standards. If our empirical test confirms our formulation and we find that we have abstracted out an aspect of the phenomenon that is the necessary condition for the existence of the total phenomenon, then we can say that we have the basis for a new standard and can proceed to think of it quantitatively.

Once an investigator has discovered new aspects of a phenonmenon that can serve as the bases for standards, it is only too easy for him to slip into the misconception that the particular operation on which he has settled as suitable to the problem at hand exhausts the subject and says all there is to be said about it. This leads to the reification of the very construct which operationism, for example, was devised to avoid. Any science becomes stagnant if it does not regard the discovery of new variables as its primary concern.

We cannot agree with those investigators who believe that the basic variables of all sciences are the same if we can only find them. As we have already pointed out, in psychology this leads to an artificial restriction of the problems dealt with, sometimes to the extent of eliminating from consideration the most pertinent variables. For example, in the attempt to study certain perceptual phenomena, emphasis has been placed on such easily defined variables as "farther than" and "bigger than," where the more psychologically meaningful variable in many cases is probably the subjective feeling of "surer than." If our awareness of a change in an external event is to be considered at all functional in nature, then the subjective sense of surety accompanying the perception must be of primary psychological significance. In the case of those perceptions we label attitudes, investigation of the surety with which attitudes are held under different conditions has lagged far behind our interest in measuring the "direction" of the attitude or opinion.

A note on analysis. The use of the term *analysis* is a poor and misleading way by which to describe the processes involved in determining the variables we will use in our scientific thinking. For analysis assumes the existence of entities existing in their own right which together make up a total phenomenon, and suggests that all we have to do is somehow isolate them, by analysis, for manipulation. Analysis becomes synonymous with the classification of variables in terms of abstracted, fixed, and reified standards.

As we have already indicated, there is an infinity of variables that provide the bases for an infinity of standards. We have said that all adjectives and adverbs furnish a potential basis for standards. And from a study of the history of our language we know that emerging situations bring their own new bases for standards—e.g., the "snafu" of the G. I. When we analyze by using existing standards we make nouns out of adjectival or adverbial relationships often without knowing. For analysis is possible only by using existing standards. Analysis thus does not add anything to our understanding of the functional activities involved in transactional relationships. Hence analysis is not at all similar to what must be regarded as the scientist's constant obligation to discover those aspects of a phenomenon except for which it would not exist. Likewise synthesis—the putting together of that which we have taken apart—is a process by means of which we cannot get any more into the synthesis than is included in the standards made use of in analysis.

The functional activities we pick out for attempted intellectual understanding are those related to the immediate hitch we face. This means, then, that although an infinite number of conditional relationships exist, in any concrete scientific pursuit the range of conditional relationships an investigator might pick out as important will be limited, and will be bounded by the nature of the hitch he has encountered. Scientific progress results from the ability to pick out the most relevant conditional relationships for empirical investigation, not by further analysis of established variables alone.

(This is the second of a series of three articles.)

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Frederick Gardner Cottrell: 1877–1948

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FREDERICK GARDNER COTTRELL, who died at the age of 71, was among those fortunate pioneers who live to see many of their dreams for the betterment of mankind come true. As a scientist, engineer, and humanist, he loved to explore new fields of applied science, to uncover new ideas which his associates might explore and test in detail, to encourage experiments, and to foster projects of promising industrial and social value.

Specifically, he made several important contributions which will be long remembered by scientists and engineers. Among them is the Cottrell electrostatic precipitator, known simply as a "Cottrell," for the precipitation of dust and mist. Also of note are his boiling-point apparatus, the Research Corporation which he established, and the chemical applications of pebble-bed furnaces.

He was a vigorous, unselfish, imaginative physical chemist and industrial engineer who acted something the part of a catalyst in bringing together inventors, engineers, scientists, and industrialists to develop new processes. In these repeated endeavors, Dr. Cottrell had no thought of personal gain or prestige, but was intent upon seeing the wheels of progress turn. He lived modestly, indeed frugally, and cared little about his own comfort. Clothes or traveling accommodations were less important to him than a visit with a productive scientist, or a good book. He read widely and was an indefatigable conversationalist. His abiding interest in people revealed itself in his spoken thoughts. His approach to a group of related ideas or to a new industrial application of science emphasized individual scientists even more than the work they had done. One idea led rapidly to another and in turn to still others, usually by association with names and faces that came to his mind. It was this intense interest in men, coupled with a keen knowledge of the facts and implications of his field of work, that enabled him to accomplish so much.

The broad scope of his interests brought him into early contact with the problem of financing research and development work. With income from patents on the Cottrell precipitator he set up the Research

Corporation, which has since given millions of dollars to support scientific research in universities and private institutions. In 1948 alone, over $750,000 was granted by the corporation for this purpose. Dr. Cottrell was instrumental also in establishing the corporation's policy of helping to put into production commercially important inventions "left on the doorstep" of educational institutions. He worked closely with the Wisconsin Alumni Research Foundation and was a director of the research foundations established at Purdue and Stanford Universities to carry out similar services.

Dr. Cottrell's publications and patents date back to 1906 and relate to many subjects, including the electrical separation of suspensions, cryogenic separation of gases, laboratory apparatus, recovery of wastes, and pebble-bed furnaces.

He was the recipient of many honors: the Perkin Medal, the Willard Gibbs Medal of the Chicago Section of the American Chemical Society, the Medal of the Mining and Metallurgical Society, the Washington Award of the Washington Chemical Society, the Holly Medal of the American Society of Mechanical Engineers, and the Medal of the American Institute of Chemists.

Many different societies claimed him as a member: the National Academy of Sciences, the American Philosophical Society, the American Chemical Society, the American Institute of Mining and Metallurgical Engineers, the American Electrochemical Society, the National Institute of Mining Engineers, the Société de Chimie Industrielle, Phi Beta Kappa, Sigma Xi, and Alpha Chi Sigma.

Frederick Gardner Cottrell, the son of Henry and Cynthia L. (Durfee) Cottrell, was born in Oakland, California, on January 10, 1877. He took his bachelor's degree in chemistry 19 years later at the University of California, spent the following year as Le Conte Fellow at the same university, and taught high school in Oakland for three years before departing for Germany for further study. He obtained his Ph.D. at Leipzig in 1902.

Returning to the University of California, he was instructor there from 1902 to 1906 and assistant professor from 1906 to 1911. In 1911 he joined the United States Bureau of Mines, where he was successively chief physical chemist on field duty (1911–14), chief chemist (1914–15), chief metallurgist (1916–19), assistant director (1919–20), and finally director. Half a year later he relinquished his position as director of the Bureau of Mines to accept the chairmanship of the Division of Chemistry and Chemical Technology of the National Research Council. Within another year, however, in 1922, he was called to head the vigorous and comparatively new U. S. *Fixed Nitrogen Research Laboratory*, where he felt he could better direct research programs without being restricted so much by administrative detail.

He was director of the Nitrogen Research Laboratory until 1927 and after its reorganization in that year remained as chief of the Division of Fertilizer and Fixed Nitrogen Investigation of the Bureau of Soils in the U. S. Department of Agriculture. Leaving this post in 1930, he continued as consultant to the bureau until 1940. Previously, he had received an LL.D. from the University of California in 1927 and had served as consultant to the Smithsonian Institution in 1928–29.

Perhaps Dr. Cottrell's most exciting period of activity occurred between 1935 and 1938, when he was president of Research Associates, Inc., an organization established to carry inventors' ideas into quick development and application.

In 1939 he persuaded the University of Wisconsin to undertake experiments which might lead to the fixation of nitrogen on an industrial scale. The principle employed involved the application of his pebble-bed method to the heating and quick chilling of air.

During World War II Dr. Cottrell's advice was sought on such projects as industrial use of domestic manganese resources, magnesium production, the manufacture of high temperature ceramics, and many others. By frequent trips around the country he kept in touch with the many researches in which he was concerned. Nominally residing in Washington, D. C., during much of his later life, he spent his final years at Palo Alto, California.

On November 15th Dr. Cottrell was enjoying the company of old friends at the meeting of the National Academy of Sciences in Berkeley on the campus of the University of California, for which he had genuine affection. Among the technical papers he heard was a review of the development of the cyclotron, in which he had been particularly interested and which had been started years before with the help of a grant from the Research Corporation. The next morning, on November 16, 1948, his heart stopped while he was attending a scientific meeting. This is the way he probably would have chosen for the ending of his vigorous, unselfish life.

TECHNICAL PAPERS

Culture of Fruits *in Vitro*

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While culture *in vitro* of plant tissues, isolated roots, stems, and seed embryos has become classical, no reports have yet been made of culture of fleshy fruits after separation of the flower from the plant.

In order to solve this problem, tomato flowers (*Lycopersicon esculentum* Mill.) of the San Jose variety have been cut off from the plant, sterilized with calcium hypochlorite, and planted in Erlenmeyer flasks containing various media. No growth occurred in a medium containing only mineral salts, sucrose, thiamine, and cysteine.

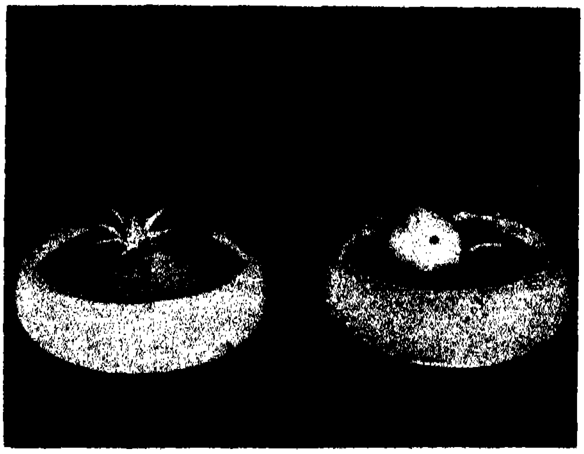

FIG. 1. *Left*, a tomato blossom planted in nutrient agar. *Right*, the tomato which developed one month later. Part of a root is visible on the right of the fruit.

The addition of sterile juice (autoclaved 15 min at 15 lb pressure) from either green or red tomatoes caused the ovaries to develop. A week after planting, the ovaries became visible, pushing up the petals and stamens which had kept them hidden (Fig. 1). The ovaries then enlarged regularly, as shown by diameter measurements, until about the 25th day after full bloom, when growth slowed down. About the 35th day, fruits turned red and ripened at the same time as the controls left on the plant. The growth curve of tomatoes growing *in vitro* (Fig. 2) is in accordance with that given by Judkins (*2*) for tomatoes attached to the plant.

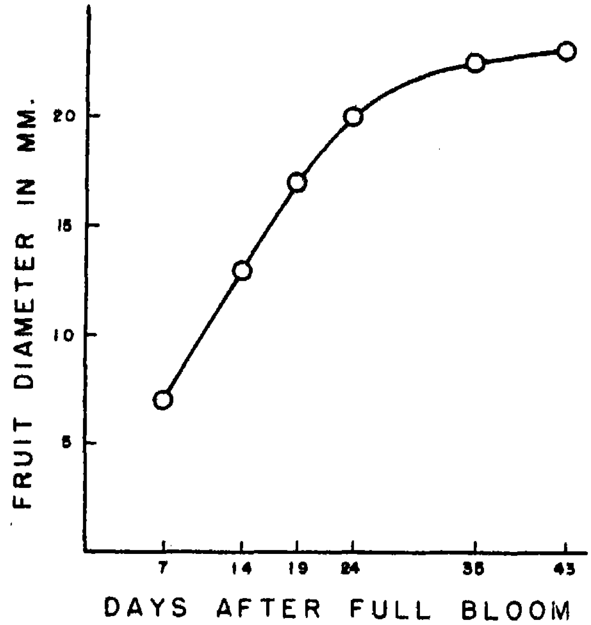

FIG. 2. Growth curve of a tomato grown *in vitro*.

Tomatoes raised from the flower in flasks tasted like usual tomatoes. They were seedless, which might be due either to lack of pollination (the plants were raised in a greenhouse where pollination was very poor) or to killing of the pollen tubes by the sterilizing chemicals. The size of the fruits was small (about 1 in. in diam), but each flower had only 40 ml of nutrient at its disposal. In some instances, roots developed on the flower stalk; such a fact has been reported only rarely in the literature (*1*).

The factors causing the action of tomato juice on root development and ovary growth were determined by the use of entirely synthetic media. Flowers planted in a medium containing mineral salts, sucrose (4%), vitamin A (1.5 mg/l), thiamine (1 mg/l), riboflavin (1 mg/l), niacin (10 mg/l), and L-tryptophane (10 mg/l) developed roots in the dark but no fruits. The same results were obtained when tryptophane was replaced by α-naphthaleneacetic acid (25 μg/l). Root development was inhibited in the light. On the contrary, using a medium containing mineral salts, sucrose (5%), thiamine (1 mg/l), cysteine (10 mg/l), and β-naphthoxyacetic acid (1 mg/l), small tomatoes were obtained which ripened in the light without the initiation of any roots.

These preliminary results show that it is possible to raise *in vitro* fruits from flowers which have been separated from the plant. Experiments are in progress to obtain full-sized fruits and to cultivate other species by this technique.

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Separating Frequency Distributions into Two Normal Components

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Separation of any frequency distribution into two component normal distributions may be effected readily if either of two assumptions can be made with validity: (1) that the means M_1 and M_2 of the components are known; (2) that the standard deviations of the components are equal.

The only other requirements for the separation are knowledge of the total frequency (or area) N of the given distribution and its mean M, standard deviation σ, third moment ν_3, and, for the second case only, fourth moment ν_4. The method for such separation, outlined by Charlier (*1*) more than 40 years ago but little noticed, is based on Pearson's (*5*) general method for finding two normal components in any distribution, which assumes nothing about them except their existence, and requires solution of a complete ninth degree equation involving the first five moments of the given distribution.

Pearson applied his method not only to markedly skewed distributions, in which the presence of two components is indicated strongly, but to some which are quite symmetrical (although not normal), to find components with identical means but differing standard deviations. His general method applies even when one of the components is negative, i.e., when the given distribution is the difference between two normal ones. This method was used by Crum (*2*) and Pollard (*8*), without reference to De Helguero's (*3*) slight modifications, to Pearson's (*7*) own refinement, or to the simple solutions developed by Charlier for two special cases of great practical significance.

Assumed Means. In obviously bimodal distributions, and many unimodal ones with pronounced "humps" or "shelves," means M_1 and M_2 for two supposed components may be apparent. Their departures from the mean M of the given distribution,

$$M - M_1 = m_1 \text{ and } M_2 - M = m_2$$

were used by Charlier (*1*) to find the variances of the two components (notation simplified):

$$\sigma_1^2 = \sigma^2 - 2m_1m_2/3 - (m_1^2/3 + \nu_3/3m_2)$$
$$\sigma_2^2 = \sigma^2 - 2m_1m_2/3 - (m_2^2/3 - \nu_3/3m_1).$$

The total areas or frequencies of each component depend only on the assumed means:

$$N_1 = Nm_2/(m_1 + m_2) \qquad N_2 = Nm_1/(m_1 + m_2).$$

Finally, from a table of normal frequency curve ordinates, $\phi(t)$, the ordinate at any distance (in t units) from the mean may be found, since

$$y_1 = (N_1/\sigma_1)\,\phi(t).$$

The larger component always corresponds to the smaller departure from the mean, which in turn is m_1 if ν_3 is positive, m_2 if negative. Should impossible means be assumed for the two components, σ_1^2 or σ_2^2 will be negative, indicating no real solution.

However, the method of assumed means does not give a unique solution: usually trial of several pairs of means is required to find one set yielding two components which, added together, closely approximate the given distribution. The best pair of means generally has maximum ordinates agreeing well with the observed values, due regard being given to the contribution each component makes to the other's peak. Such agreement can be made as close as desired by assuming values of the maximum ordinates y_1 and y_2 in addition to the means M_1 and M_2. Then

$$\sigma_1 = N_1/\sqrt{2\pi}\,y_1 \quad\text{and}\quad \sigma_2 = N_2/\sqrt{2\pi}\,y_2.$$

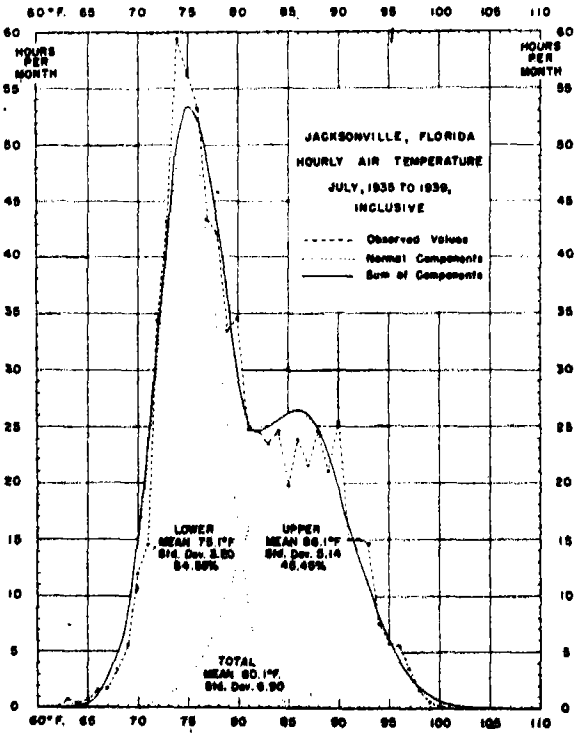

FIG. 1.

Example. Charlier's method of assumed means (without assuming values for the maximum ordinates) has been applied (Fig. 1) to 3720 hourly temperature readings during July at Jacksonville, Florida; significance of the two components found by this method will be discussed elsewhere. In the data, even temperatures are disproportionately more frequent than odd ones, because observers, required to estimate readings to tenths of a degree, tended to values ending in 0.0 or 0.5; the latter, by the classic rule for disposal of decimals, then were rounded to the nearest even degree. If, instead, all 0.5 values were rounded to the *next higher* units, frequency distributions would be smoother and means too high by only 0.05°.

For these Jacksonville data, several pairs of assumed means were tried and discarded before two finally were found yielding components whose sum (Fig. 1) seems a reasonable approximation to the original curve. A still better fit might have been obtained from means differing from the given mean by tenths of a degree, instead of by the half-degree intervals fixed upon to simplify computations.

Equal standard deviations. Assuming the two presumed components to have equal standard deviations, instead of assuming values for their means, led Charlier (*1*) to a cubic equation involving the difference between the variances of the given distribution and the assumed components:

$$z^3 + \tfrac{1}{2}(\nu_4 - 3\sigma^4)z + \tfrac{1}{2}\nu_3^2 = 0,$$

where $z = \sigma_1^2 - \sigma^2$. The discriminant of this cubic,

$$C^2 = (\sigma^{12}/216)\ (13.5\alpha_3^4 + E^3),$$

where $\alpha_3 = \nu_3/\sigma^3$ is the skewness and $E = (\nu_4/\sigma^4) - 3$ the excess, almost always is positive, indicating only one real root:

$$z = 0.4082\,\sigma^2\,(\sqrt[3]{-3.6742\alpha_3^2 + \gamma} - \sqrt[3]{3.6742\alpha_3^2 + \gamma}),$$

where $\gamma = \sqrt{13.5\alpha_3^4 + E^3}$.

Except for almost symmetrical and very flat-topped distributions, γ is positive, so that z will be negative, and

$$\sigma_1^2 < \sigma^2.$$

But if $-z > \sigma^2$, then σ_1^2 is negative, and there is no actual solution, indicating the assumption of equal standard deviations to be unwarranted; for Jacksonville July temperatures, variances assumed to be equal are -5.07.

If the assumption is justified, and σ_1 is real, the means are:

$$M_1 = M - m_1 = M - (\nu_3/6) - \sqrt{(\tfrac{1}{4}\nu_3)^2 - z}$$

$$M_2 = M + m_2 = M - (\nu_3/6) + \sqrt{(\tfrac{1}{4}\nu_3)^2 - z}.$$

The areas N_1 and N_2 of the two components are found as before.

An asymmetrical curve which is the sum of two normal curves "affords a good fit both to distributions which possess two distinct modes, and to skewed distributions with one mode" (*8*). That components have not been found generally for such distributions may be due to ignorance of Charlier's facile methods; this ignorance, in turn, may stem from Pearson's insistence (*6*), replying to Edgeworth's criticism (*4*), that his "process is not so laborious that it need be discarded for rough methods of approximation based upon dropping the fundamental nonic and guessing suitable solutions."

Of Charlier's methods, the first, that of assumed means, is far simpler than the second, which involves the fourth moment and a cubic equation. However, Charlier concentrated on the second, the "abridged method for dissecting frequency curves," because the cubic equation involved is actually one step in the general solution, "hence it is no loss of time to begin with this approximate method."

Charlier declared that the assumption that the standard deviations of the two components are equal "is of a more general character" than the assumed knowledge of the means of the two components. "Especially in biology it is a fairly probable supposition that two types found together in nature often possess *nearly* equal standard deviations," but "this abridged method is applicable only when there are a priori reasons for the assumption that the two components have nearly equal standard deviations." In many cases no such reasons exist, and then it is safer to assume certain values for the means of the components, especially when approximate means may be determined by inspection. In the example given, the approximate values of the means were obvious from the graph, and trial of a few pairs of values yielded one which gives a good fit, with markedly different standard deviations; assumption of equal deviations gave no solution.

Even closer agreement with the original distribution can be obtained if values may be assumed for the maximum ordinates as well as the means of the two components. In effect, this short cut replaces the standard deviation and skewness of the original distribution by a subjective evaluation which may be more effective for some distributions, but is not of as general applicability in finding two normal components.

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Combination of Tissues from Different Species in Flask Cultures[1]

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Combining tissues from different species apparently has been performed only infrequently in tissue culture. Roffo (*5*) grew together chicken and rat tissues, both normal and neoplastic, without evidence of antagonism. In studies of the mode of transmission of the excitation involved in cardiac muscle contraction, several investigators (for reference see Leone [*3*]) combined embryonic heart fragments of the chick with similar fragments from other avian and mammalian species. The establishment of synchrony of beat was reported, and no mention was made of any incompatibility reactions.

Harris (*2*), in an attempt to determine whether direct incompatibility exists between tissues of different mammalian species in culture, paired heart, spleen, and kidney fragments from newborn mice and rats in roller tubes. Harris found that ". . . rat and mouse tissue cells are physiologically compatible *in vitro*." In a related study, though not involving tissues from different species, Medawar (*4*) recently made combined fluid cultures of skin from two adult rabbits, between which skin grafts had failed to take, and found no evidence of incompatibility. The present report confirms these earlier observations, in that no overt incompatibility has been found in combined cultures of tissues from mouse and rat, mouse and guinea pig, and mouse and chicken, even when the mouse tissues were derived from animals previously immunized against the opposite species.

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TABLE 1

SUMMARY OF MOUSE-RAT TISSUE COMBINATIONS

Mouse (strain C)	Rat (strain Marshall or Hairless)	Duration of experiment (days)	Total number cultures
Kidney, 16-day embryo	Kidney, embryo, near term	6	2
" adult	" adult	6	2
Spleen, 16-day embryo	Spleen, embryo, near term	6–11	5
" adult	Kidney, embryo near term	6	2
" "	" adult	6	2
" "	Spleen, "	6	1
			14

All cultures were carried in modified Carrel D-3.5 flasks. Aseptically prepared tissue fragments, 1–2 mm in diam, were planted several millimeters apart in a clot of 0.6 ml chicken plasma and 0.8 ml of a nutrient fluid consisting of 2 parts horse serum,[3] 2 parts Tyrode's solution,[4] and 1 part chick embryo juice. After the clot formed, 1.0 ml of the nutrient fluid was added to each flask. Three times weekly the nutrient was drawn off, the cultures were washed with 2.0 ml of Tyrode's solution, and fresh nutrient added. In some cases (see Tables 2 and 3), the chick embryo juice was omitted from the nutrient in order to slow the rate of growth.

TABLE 2

SUMMARY OF MOUSE-GUINEA PIG TISSUE COMBINATIONS

Mouse (strain C)	Guinea pig (family 13)*	Duration of experiment (days)	Total number cultures
Kidney, 16-day embryo	Kidney, embryo, near term	4	3
Spleen, 16-day embryo	Kidney, embryo, near term	4	1
Spleen, 16-day embryo	Spleen, embryo, near term	4	2
Spleen, adult	Spleen, adult	6	3
" "	Kidney, young, 7–9 days	11	5
" " †	Kidney, young, 7–9 days	11	6
" " ‡	Kidney, young, 7–9 days	11	6§
Lymph node adult	Kidney, young, 7–9 days	11	11§
Lymph node adult†	Kidney, young, 7–9 days	11	11§
Lymph node adult‡	Kidney, young, 7–9 days	11	5§
			53

* Inbred line developed by Dr. Sewall Wright and maintained by Dr. Walter Heston at this institute.

† Donor mouse immunized with guinea pig serum.

‡ Donor mouse immunized with guinea pig kidney.

§ Chick embryo juice omitted from nutrient fluid in one half of cultures.

Tables 1–3 list the various tissue combinations studied. Strains and ages of donors are given in the tables. Omitted are the controls which were run in each experiment and which consisted of cultures of paired tissue fragments from one species—either mouse, rat, guinea pig, or chicken.

Early contact of individual cells, as well as the later stages of growth, was observed microscopically. At intervals, representative cultures were photographed and, in some cases, fixed and stained, using a modification of the technique of Earle (*1*).

TABLE 3

SUMMARY OF MOUSE-CHICKEN TISSUE COMBINATIONS

Mouse (strain C)	Chicken (stock)	Duration of experiment (days)	Total number cultures
Kidney, 16-day embryo	Heart, young, 7–9 days	21	9*
Kidney, young, 7 days	Heart, young, 7–9 days	21	9
Spleen, 16-day embryo	Spleen, young, 7–9 days	4	2
Spleen, young, 7 days	Heart, young, 7–9 days	21	9*
Spleen, adult	Kidney, young, 7–9 days	4	3
" "	Heart, young, 1 day	8	9
" " †	Heart, young, 1 day	8	9
			50

* Chick embryo juice omitted from nutrient fluid in one half of cultures.

† Donor mouse immunized with chicken serum.

To determine whether immunization of one species against antigens from another affects the reactions of their tissues when combined in culture, groups of young mice (5–7 weeks old) were injected with either guinea pig serum (diluted 1: 7 with saline), guinea pig kidney (brei diluted 1: 10), or chicken serum (diluted 1: 3). The immunization course consisted of intraperitoneal injections twice weekly for 3 weeks. The total amount of diluted antigen given was 4.5 ml. One week after the final injection the mice were bled, along with controls, and the desired tissue taken for culture. Pooled serum samples were tested for antibody content by the "ring" precipitin test. Antibody titers of 1: 64 in the anti-guinea pig sera, and 1: 640 in the anti-chicken serum.

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[3] Kindly supplied by Dr. Wilton R. Earle.

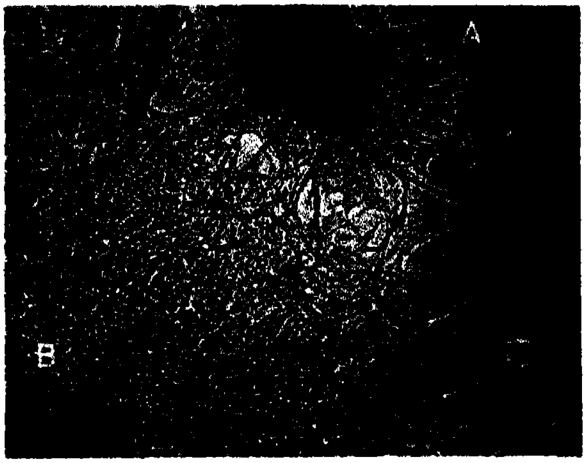

FIG. 1. Four-day combined culture of (A) spleen of mouse immunized with chicken serum, and (B) 1-day-old chick heart. Note that outgrowth zones have joined and that there is no evidence of antagonism. Magnified 90×.

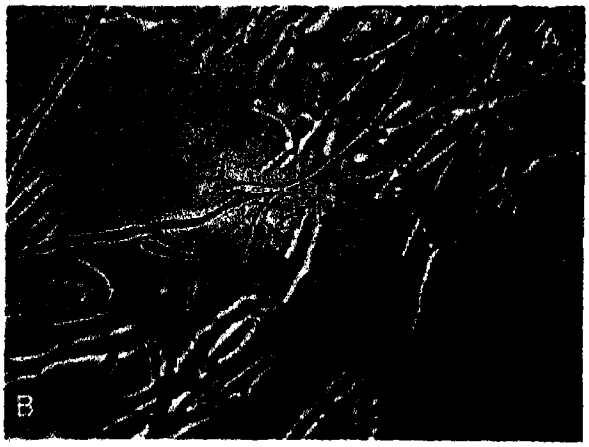

FIG. 2. Four-day combined culture of (A) lymph node of mouse immunized with guinea pig serum, and (B) 3-day-old guinea pig kidney. Intimate contact of normal cells from the two species can be observed. Magnified 280×.

During the first few days of incubation, extensive cellular migration occurred from all explants. In cultures of tissues from different species, cells at the margins of the outgrowth zones came into intimate contact with each other (Figs. 1 and 2) as in cultures of tissues from the same species. In both types of culture, the cells in the contact zone, as elsewhere, appeared normal. The cells were observed to come together in the contact zone and, as migration continued, the margins of the outgrowth zones were joined without any sharp demarcation. There was no evidence of: 1) abnormal cellular accumulation or reaction along the line of junction between the two explants, 2) altered rate or direction of growth in the contact area, or 3) specific attraction or antagonism between cells of the two species. Once the growth zones joined, continued cultivation with or without embryo juice, up to a maximum of 21 days, produced no further change, apart from progressive growth of the cultures.

The growth patterns described were identical in the case of combinations involving explants from previously immunized animals. Tissues of immunized mice, as compared with those of nonimmunized mice, showed no difference in reaction to tissue fragments from the species that furnished the antigens.

The results show that tissues of two different species, as widely diverse as mouse and chicken, may be grown simultaneously in flask culture without apparent antagonism. This is true even when the donor mouse has been previously immunized against antigens of the species furnishing the other tissue of the paired combination, and when the mouse tissue is one which *in vivo* presumably is intimately involved in antibody formation, i.e., spleen and lymph node. At present, the chief significance of these findings is seen in the possibility that such combined cultures may provide a method for investigations requiring maintenance of healthy tissues of two species in close physiological relations.

Further investigation is necessary before these results may be interpreted in relation to problems of antibody production *in vitro* and of incompatibility in transplantation *in vivo*. Interpretation at present is hindered for the following reasons: First, no attempt was made to provide optimum conditions for antibody production, or its detection in the culture fluids. Second, the media used contained components heterologous for both species, thereby complicating immunological interpretations. Finally, in the present state of knowledge of cellular physiology in culture, it is not safe to transfer directly to the organism conclusions based upon observations of cellular behavior *in vitro*.

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Transphosphorylation by Alkaline Phosphatase in the Absence of Nucleotides[1]

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Axelrod (*1*), using citrus fruit phosphatase, observed the transfer of phosphate from nitrophenyl phosphate to methanol in the absence of nucleotides. The transferred phosphate did not pass through the inorganic stage. Recently, we observed with alkaline intestinal phosphatase a strong acceleration of the rate of synthesis of glycerophosphate from inorganic phosphate and glycerol, in the presence of biological compounds with phosphate bonds of higher energy than glycerophosphate (*2*).

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[1] This work was aided by grants from the American Cancer Society, recommended by the Committee on Growth; the Division of Research Grants and Fellowships of the National Institutes of Health; and the Rockefeller Foundation.

It has since been established that this acceleration is achieved in the absence of nucleotides by a direct phosphate transfer, that is, without passing through the intermediary stage of inorganic phosphate. When a mixture of P^{32}-labeled phosphocreatine, synthesized enzymatically (*3*), unlabeled inorganic phosphate, and glycerol was incubated with intestinal phosphatase at 38° C for 15 and 30 min, the glycerophosphate in excess of that synthesized in the absence of phosphocreatine (representing two-thirds to three-fourths of the total glycerophosphate) had about the same specific activity as the phosphocreatine, while the specific activity of the inorganic phosphate was quite low. If the phosphate transfer had passed through the intermediary stage of inorganic phosphate, then the specific activity of the glycerophosphate synthesized could not be higher than that of the inorganic phosphate. Similar results were obtained with radioactive phosphocreatine, fructose, and inorganic phosphate: at the end of 15 min of incubation more than half of the total fructose-phosphate formed derived its phosphorus directly from the phosphocreatine. Other observations indicate that phosphopyruvate glucose-1-phosphate (and similar compounds with relatively high phosphate bond energy) can also participate as phosphate donors in such a direct phosphate transfer.

TABLE 1

SPECIFIC ACTIVITIES OF THE PHOSPHATE SPECIES IN THE PHOSPHORYLATION OF GLYCEROL AND FRUCTOSE AT 38° C WITH PHOSPHOCREATINE LABELED WITH P^{32}

	Initial molar concentration	% Acceleration of synthesis	Specific activity cpm/γ P	
A			0 min	30 min.
Phosphocreatine	0.0252		1090	895
Inorganic P	0.448		0	9.3
Glycerol	1.63		–	–
Glycerophosphate	0.0	290	0	606*
B			0 min	15 min
Phosphocreatine	0.030		1828	1750
Inorganic P	0.444		0	18.3
Fructose	2.34		–	–
Fructose-phosphate	0.0	375	0	780*

* Corrected for the nonlabile P impurities present in the phosphocreatine preparation.

In Table 1 the specific activities (cpm/γ P) of the different phosphate species from two such experiments are given. The general composition of the enzymatic incubation mixture was the same as previously reported (*2*).

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Hatching Eggs of Floodwater Mosquitoes in Media that Promote Plant Growth[1]

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In a natural environment, eggs of floodwater mosquitoes are deposited on soil, in debris, or among plants in places subject to transient submergence. In such sites they remain in a viable state for a year or longer, and usually hatch when they are flooded with water at a proper temperature. However, submergence in this manner is not a dependable provocation for hatching eggs of these mosquitoes in the laboratory, according to numerous observers. Water in natural habitats must contain stimulants to hatching that are not found in tap water. Several observers have noted that durable eggs of the genus *Aedes* may be stimulated to hatch by infusions made from plants that grow in the natural oviposition sites and by cultures of bacteria and yeasts. Abdel-Malek (*1*) found that eggs of *Aedes trivittatus* Coq. hatched erratically in dilute solutions of chemicals that regulate plant growth such as 1-naphthaleneacetic, 3-indoleacetic, and 3-indolebutyric acids. No one seems to have devised a way to get eggs to hatch in consistently high percentages in a few hours, as occurs in nature.

Larvae of floodwater mosquitoes hatch after two phases of growth have been completed in the egg. The first is an increase in number of cells, which continues until the fully formed embryo occupies all of the interior of the egg. The second is an increase in size of the embryo, until the shell of the egg is ruptured. Between the two periods, eggs may be dormant for months. Temperature regulates the rate of increase of cells, and the nature of the solution surrounding the eggs has much to do with initiating escape of the larvae. The final act of hatching involves an increase in size of the embryo in a manner similar to the elongation phase of growth of plant tissue. Media that stimulate one might affect the other similarly.

Eggs of the floodwater species, *Psorophora discolor* (Coq.) may hatch at any time after the embryos are fully formed. Maturation of the embryo requires about 4 days at a temperature between 22 and 26° C. If kept on a moist surface at a temperature within this range, larvae may hatch whenever the eggs are submerged in a suitable medium. Eggs kept on a moist substratum at a temperature of 15–20° C in the laboratory have survived and yielded vigorous larvae after at least 9 months. However, prolonged exposure of eggs to temperatures as low as 15–20° C will prevent any medium from causing hatching until the eggs are conditioned for several days at a temperature favorable for hatching.

Substances that promote growth of plant tissues vary in effectiveness. Thimann (*3*) states that short sections of etiolated oat coleoptiles will elongate slightly in water, more in water containing purified growth-promoting substances, and vastly more when sugar is added to the medium. He further states that a suitable medium for the purpose of growing plant tissue contains sucrose 1%, potassium chloride M/100, and indoleacetic acid 1–5 mg/l. Caplan and Steward (*2*) have shown that dilutions of milk from ripe coconuts, and corn lyophilized while in the milk stage contain factors that stimulate growth of carrot explants many times more than purified indoleacetic acid alone. The purpose of this paper is to show the order of increasing influence of various types of media on the hatching of eggs of a common species of floodwater mosquito, *Psorophora discolor.*

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[1] Contribution No. 290 of the Department of Entomology, University of Illinois, Urbana.

TABLE 1

INFLUENCE OF VARIOUS MEDIA ON THE HATCHING OF LARVAE FROM EGGS OF *Psorophora discolor* IN THE LABORATORY

Medium	Age of medium	Eggs treated	Larvae hatched					
			0–4 hr		5–24 hr		Total	
	days	no.	no.	%	no.	%	no.	%
Extract of canned corn	0	120	93	77	5	4	98	82
Coconut milk (5%)	0	330	243	74	21	7	264	80
Glucose, KCl, and indoleacetic acid	2–7	180	137	76	2	– 1	139	77
Glucose, KCl, and acetic acid	3–5	240	141	59	21	9	162	68
Glucose, and acetic acid	2–3	180	107	60	11	6	118	66
Glucose, and ethyl alcohol	3	260	49	19	102	39	151	58
Sucrose, KCl, and indoleacetic acid	0	20	0	0	98	81	98	81
Glucose, KCl, and acetic acid	0	180	0	0	127	71	127	71
Glucose, KCl, and indoleacetic acid	0	180	0	0	116	64	116	64
Glucose, and acetic acid	0	90	0	0	52	58	52	58
Glucose, and KCl	0	90	0	0	53	59	53	59
Glucose	0	180	0	0	102	57	102	57
Indoleacetic acid (5–10 ppm)	0	60	0	0	26	43	26	43
Indolepropionic acid (2–10 ppm)	0	70	2	3	24	34	26	37
Indolebutyric acid (2–10 ppm)	0	70	0	0	25	36	0	36
Yeast suspension	0	40	0	0	5	12	5	12
Indoleacetic acid (0.1–2.0 ppm)	0	250	1	– 1	13	5	14	6
Acetic acid (20–100 ppm)	0	300	6	2	4	1	10	3
Indoleacetic acid (20 ppm)	0	30	3	10	0	0	3	10
Tap water	0	340	4	1	2	– 1	6	2
Potassium chloride	0	30	0	0	0	0	0	0

Preparations for observing the effects of various media on the rate of hatching of eggs were carried out in the following manner. Solutions were prepared by dissolving the ingredients in tap water without sterilization. Some were used as soon as they were prepared, and others were aged at 20° C for periods of time shown in Table 1. All solutions of glucose and sucrose contained 10,000 ppm of the sugar. Potassium chloride was used at the concentration of 7460 ppm. Indoleacetic acid, in all solutions containing sugar, was used at a concentration of 5 ppm; otherwise dilutions were as shown in the table. Acetic acid and ethyl alcohol were used in concentrations of 100 ppm. The extract of canned corn (used in lieu of lyophilized corn) was composed of the turbid filtrate from a mixture of 1 part of cream-style corn in 4 parts of water. Coconut milk was diluted to 5% of normal. The yeast suspension consisted of four pellets of living dried yeast dropped into a tube of tap water containing the eggs. Eggs were submerged in the media, and records were made of the number of larvae hatched after 4 and 24 hr. Some media caused hatching for 48 and 72 hr, but no data are included for intervals longer than 24 hr. All eggs were stored on moist cellucotton for 4–5 months at 15–18° C and conditioned for 10 days at 26–27° C before submerging them.

Hatching of conditioned, durable eggs of *Psorophora discolor* was stimulated by substances that effect plant growth, as is seen in Table 1. Tap water alone had hardly any effect on the process when eggs had been conditioned only 10 days. Purified substances, when used in concentrations of 2–10 ppm, stimulated 36–43% of the eggs to hatch within an interval of 24 hr, but they were ineffective during the first 4 hr. Similarly, solutions containing glucose, when freshly prepared, caused no hatching within 4 hr, but within 24 hr 57–71% of the eggs were hatched. Diluted fresh coconut milk and a freshly prepared extract of commercially canned cream-style corn caused hatching of 80–82% of the eggs. The last two media caused most hatching within 4 hr.

Aging of all solutions containing sugar advanced the time of hatching so that nearly all eggs hatched within 4 hr after submergence. However, the total number of eggs hatched was less in all aged media (with one exception) than was the case with relatively sterile coconut milk and extracts of canned corn. The exception was the aged medium containing glucose and indoleacetic acid, which caused as high a percentage to hatch as rapidly as those containing coconut milk and corn extract. Aged media containing ethyl alcohol were inferior to others in ability to stimulate hatching. Only 19% of eggs treated with media containing alcohol hatched within 4 hr, and 58% hatched within 24 hr.

Media containing sugar were suitable for development of certain bacteria and yeasts, and these may have added some stimulus to hatching. Yeast alone in tap water provides no stimulant for hatching that is very effective within 24 hr. The suspension used caused no hatching within 4 hr and very little within 24 hr. Therefore yeast alone is not likely to have added a stimulant to the aged media containing sugar that brought about hatching within 4 hr.

Durable eggs of *Psorophora discolor*, when submerged in media that promote growth in plants after a proper period of conditioning, hatch in a manner analogous to the elongation reaction of plant tissue. Water alone permits little or no hatching; purified stimulants cause less than half of the eggs to hatch; sugar in the medium may favor microorganisms that shorten the interval between submergence and hatching and increase percentage of hatch; freshly prepared extract of commercially canned cream-style corn and dilutions of coconut milk hasten hatching and increase the number of larvae hatched.

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A New Apparatus for Recording of Ecologic and Climatic Factors, Especially Temperature

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For many purposes it is of interest to know for what length of time the temperature has been above a certain point, e.g., 0° C. A recorder that can supply this information may be constructed using the following principle.

If a ray of light of constant intensity illuminates a photographic plate, and the plate after a certain period is removed and developed, the degree of darkness will be a function of the time during which the plate has been illuminated. If the illuminated spot moves as a function of temperature, and such an apparatus is placed under varying temperatures, one may, after a certain period, remove and develop the plate. By photometry of the picture thus obtained, one may tell something about which temperatures occurred during the time of exposure, and the frequency of occurrence of each temperature.

A paper impregnated with a salt of a radioactive element of sufficiently high stability, e.g., a salt of radium, supplies a constant source of radiation that affects a photographic plate.

On this principle, the apparatus shown in Fig. 1 has been constructed.

A pointer (4) is connected with a bimetal strip (2) which bends with temperature. At the tip of the pointer, a metal plate is placed, and through this a slit (5) is cut. The slit is 1 cm long and consists of two parts, an outer one 0.5 cm long and 0.4 mm wide, and an inner one 0.5 cm long and 0.2 mm wide.

The system of bimetal strip and pointer is fastened in a metal case (1). The pointer moves parallel to the lid of the case (6).

The lid seen from below is pictured in Fig. 1 c. There is a frame (7) with two springs (8). In this frame a photographic plate is fastened so that two sides of the plate are pressed towards two sides of the frame. Thus the photographic plate is placed in a known position.

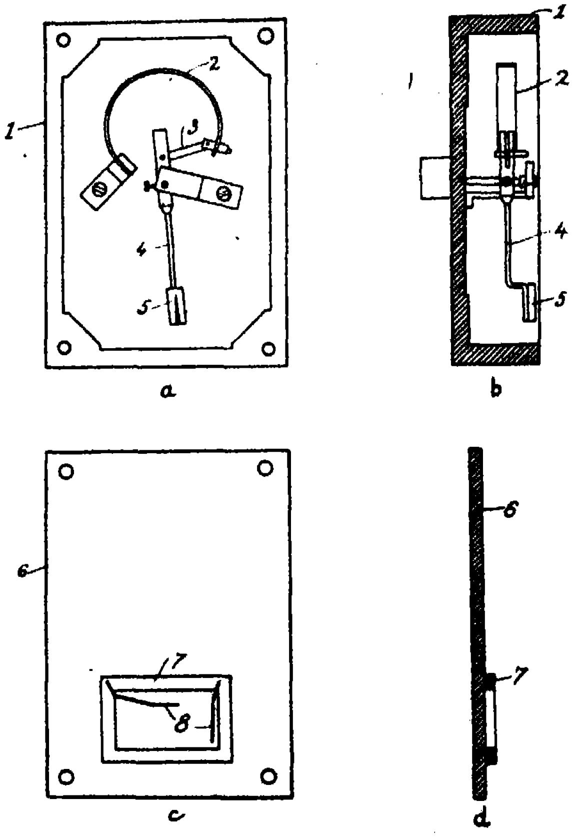

FIG. 1.

On the under side of the slit, a piece of paper impregnated with radium sulfate is fastened. Only the α- and β-particles going through the slit can reach the photographic plate. Some of the γ-rays going through the metal plate will reach the photographic plate, but if a fine-grained type of plate is employed, the photographic effect of the γ-rays is negligible in comparison to the effect of the α-particles.

When a photographic plate is placed in the frame, the lid fastened to the case, and the apparatus left under varying temperatures, different parts of the plate will be exposed to radiation at different temperatures. Each time a certain temperature occurs, one definite sector of the plate will be exposed, and in the course of time the exposures will be superimposed and added.

When the plate is removed and developed, and a photometric curve is made across the "spectrum" thus obtained, it is possible to calculate from it which temperatures occurred during the observation period, and the part of the observation period during which the temperature was higher than a given value. To obtain such results certain points must be taken into consideration:

1. A suitable photographic plate must be chosen. It should be fine-grained and should not change its properties even during long observation periods. The Agfa Normal Diapositive Plate serves this purpose.

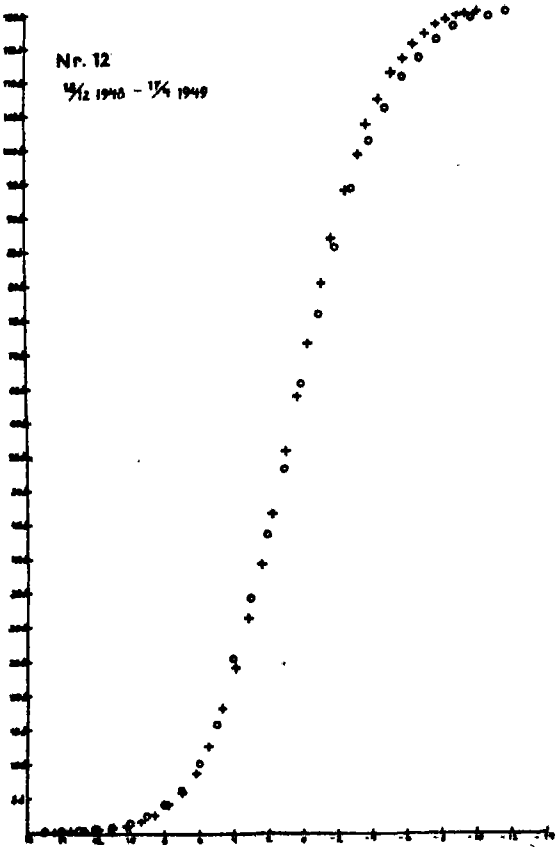

FIG. 2.

2. A suitable balance between the observation period, the activity of the radioactive paper, and the sensitivity of the plate must be found. For recordings of over one year an amount of approximately ½ γ radium sulfate/cm² was found suitable.

3. The relation between the time of exposure and the degree of darkening of the photographic plate must be found. The relation is very closely linear when a fine-grained plate is subjected to radiation by α- and β-particles even at low intensities.

4. The sensitivity of the plate as a function of temperature must be found. An experiment gave a sensitivity increase of 8% when the temperature was raised 23° C. This is an error for which correction must be made.

5. A standard exposure at definite temperatures must be made and photometric curves must be taken in the same way as in the original plates, to know which sectors of the plate correspond to which temperatures.

6. Because the slit has a certain width, the photometric curves give only an approximate representation of the relationship between the temperatures and the frequency of occurrence of each temperature interval, an error for which a correction must be made.

As a test, some of the apparatus was left for a certain period in the observation hut of the Norwegian Meteorological Institute at Blindern, Oslo, where continuous recordings with thermographs are made. From the thermograph curves the same factors may be calculated as from the photometric curves.

One of the results is given in Fig. 2. The ordinate shows number of days with temperatures higher than that given on the abscissa. Circles represent values calculated from the thermograph curves; crosses, values calculated from the photometric curves. The correspondence is good.

It will be evident that the same principle, although only with approximation, may be employed in all factors where the records can be transferred to the movement of a pointer, e.g., humidity, barometric pressure, etc. However, one does not know at which temperatures the exposures were made, and errors due to differences in the sensitivity of the plate with temperature cannot be corrected for. This difficulty may be overcome by making the width of the slit variable. If one side of the slit is fastened to a bimetal strip, this may be arranged so that the width of the slit decreases at higher temperature to compensate for the differences in sensitivity of the plate. Thus the same principle may be applied over a wide range of ecologic, climatologic, and other types of instruments.

A more detailed description and discussion is found in *Physiologia Plantarum*, 1949, 2, 272.

Cup Assay with Vitamin B_{12} as a Standard

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The cup assay method proposed by Heatley (*1*) for the estimation of penicillin has several advantages over standard turbidimetric or titrimetric procedures. Chief among these is the adaptability of the method to routine handling of large numbers of samples from a variety of sources. Evaluation of reproducibility of the method and discussion of factors influencing it have been presented by Heatley (*6*). The requirements for satisfactory microbiological assay methods have been listed by Foster and Woodruff (*4*).

Assays for biotin, thiamine, and riboflavin (*2*, *5*) by the cup assay technique have been described. The factors crucial for antibiotic cup assays apply equally to the determination of growth-promoting factors by the cup method.

The microbiological estimation of LLD (*L. lactis* Dorner) type activity by means of *Lactobacillus lactis*, or by means of *L. leichmannii*, using vitamin B_{12} (*10*) as a standard, is influenced by degree of aeration, by oxidation-reduction potential, and by accumulation of peroxides. These factors are difficult to control in the titrimetric assay procedure (*8, 9*). The cup technique has allowed more rigid control of influential factors, with a resulting assay of much greater precision. Also, by use of abnormal salt concentrations, it has been possible to eliminate the diffuse growth response of the test culture to desoxyribonucleic acid or to its constituent nucleosides.

The constituents of the medium described for the Merck modification (*3*) of the Shorb titrimetric estimation of LLD activity (Table 1) are combined as a dry mix and milled in a hammer mill or ball mill, in an area of low humidity. This milled ingredient dry mix is incorporated in the assay medium to give the final composition as shown in Table 1.

TABLE 1

Item	Amount
Milled ingredient dry mix (See Table 2)	22.9 g
Spray-dried HCl-hydrolyzed casein*	1.0 g
Adenine, guanine, and uracil solution†	10.0 ml
Sodium chloride‡	20.0 g
Agar	20.0 g
Distilled water	To 1 l

* Prepared by refluxing Sheffield high nitrogen casein with 20% HCl for 20 hr, then passing the hydrolyzate through a bed of an anion-exchange resin to neutralize the excess acid, and finally spray-drying it.

† Solution contains 1 mg/ml each of adenine sulfate, guanine hydrochloride, and uracil in distilled water, acidulated with just enough H_2SO_4 to maintain the ingredients in solution.

‡ Added in order to eliminate growth response to desoxyribonucleic acid, thymidine, or reducing substances.

This assay medium is sterilized by autoclaving 20 min at 120° C, in 1-liter quantities, which may be combined to yield sufficient medium for assay of all the samples accumulated on a single day. The medium, without adjustment, is at pH 6.2 after sterilization.

An alternate medium, which is less expensive for routine assays, may be prepared by incorporating 20 g L-cystine, 20 g DL-tryptophane, 10 g DL-aspartic acid, 20 g DL-α-alanine, and 20 g ammonium acetate in the dry mix, in place of the 18 amino acids listed in Table 2. For each liter of final medium, 20.1 g of alternate mix and 2 g of spray-dried HCl-hydrolyzed casein are required. Additional supplements are added, as in the previously described medium. Although growth response is adequate from the alternate medium, it is preferable to use the complete mix whenever possible, rather than to rely on the variable composition of casein preparations as a source of essential amino acids.

Inoculum is prepared by 18-hr incubation of *L. lactis* Dorner A.T.T.C. No. 10,697[1] in the assay medium without agar and NaCl, but supplemented with 0.0001 μg of vitamin B_{12} per ml. Five ml of the inoculum culture, which should give a transmission of 25 on an Evelyn photoelectrometer with 520 mμ filter, is transferred to each liter of liquefied assay medium, precooled to 52° C.

TABLE 2

INGREDIENTS FOR DRY MIX FOR CUP ASSAY*

20 g	DL-Isoleucine	1000 g	Dextrose
20 g	DL-α-Alanine	600 g	Sodium acetate
20 g	[illegible]Cystine	50 g	Fumaric acid
20 g	DL-Aspartic acid	50 g	Sodium ethyloxalacetate
20 g	DL-Norleucine	20 g	$MgSO_4 \cdot 7H_2O$
20 g	L-Tyrosine	1 g	NaCl
20 g	DL-Valine	129 g	$Na_3PO_4 \cdot 12H_2O$
20 g	DL-Methionine	67 g	K_3PO_4
20 g	DL-Glutamic acid	1 g	$FeSO_4 \cdot 7H_2O$
20 g	DL-Threonine	1 g	$MnSO_4 \cdot 4H_2O$
20 g	DL-Serine	20 mg	Riboflavin
20 g	DL-Phenylalanine	20 mg	Calcium pantothenate
20 g	DL-Leucine	20 mg	Thiamine HCl
20 g	L-Histidine	20 mg	Nicotinic acid
40 g	DL-Tryptophane	40 mg	Pyridoxamine
20 g	L-Arginine	4 mg	*p*-Aminobenzoic acid
10 g	L-Lysine	0.04 mg	Biotin†
20 g	Aminoacetic acid		

* Total mix contains 2280 g, sufficient for 100 l of assay medium.

† This small amount of biotin may be conveniently incorporated in dry form in the mix by mixing 0.4 ml of a stock solution of biotin containing 0.1 mg of biotin per ml with 5 ml of a water solution containing 1 g of the 20 g of DL α-alanine required in the final mix, and evaporating to dryness on a water bath.

Inoculated medium is distributed into flat-bottom Petri dishes in 25-ml quantities and allowed to harden. Assay cylinders are then placed on the agar surface and the dishes stored at 4° C until needed. Solutions containing 0.03, 0.05, 0.1, 0.2, 0.4, and 0.6 μg B_{12} per ml, M/50 pH 5.2 Na_2HPO_4-KH_2PO_4 buffer are prepared for daily determination of a standard curve. Check standard solution containing 0.2 μg B_{12} is included on assay plates, in addition to unknowns diluted to approximately this level with M/50 buffer. Three assay cups are filled with standard solution and three alternate cups with unknown solution in each Petri dish.

After 18-hr incubation at 37° C, diameters of growth zones are measured and calculations made in the same manner used for antibiotic assays. A typical assay yields 1.8-mm growth zone diameter increase for each twofold increase of B_{12} concentration and approximately 17-mm growth zone for the 0.2-μg check standard.

Standard deviation (66% confidence limit) for the cup assay is ±10% as compared with ±21% for the titrimetric assay, with similar replication and the same assay organism.[2]

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[1] Kindly supplied by Dr. Shorb, University of Maryland, College Park.

[2] One cup assay is calculated from the average diameter of three zones of solution under test and three zones of standard solution on a single Petri dish. One titrimetric assay is the averaged value from five assay tubes at different concentration gradients, compared with 20 tubes containing standard solution at concentration gradients.

By the cup technique, *L. lactis* shows no response to thymidine, desoxyribonucleic acid, or 0.5% ascorbic acid. Response is obtained with crystalline vitamin B_{12}, vitamin B_{12a} (7), liver concentrates, and certain microbiological fermentation products. The fermentation materials frequently require autoclaving to destroy associated antibiotics, or acidification for release of LLD growth-promoting factors from the cells. Insoluble adsorbates, and fermentation residues, often yield full activity following suspension in water and apportioning the suspension directly into assay cups, although supernatant liquors from such suspensions may contain little growth factor.

In order to obtain full LLD activity with some adsorbates, such as APF adsorbates, it is necessary to dilute suspensions to 0.05 μg B_{12} equivalent per ml. For these samples, the check standard solution should also contain 0.05 μg B_{12} per ml.

In the cup assay described, quantitative values are assigned to the growth response of *L. lactis* Dorner (A.T.T.C. No. 10,697) to unknown preparations on the basis of an assumed value of 11×10^6 activity units per mg of vitamin B_{12}. To distinguish from the Shorb LLD unit (*11–13*), the unit of *L. lactis* Dorner activity as determined by the herein-described cup method is designated as the LLDCC unit of LLD type activity. The cup assay shows no LLD response to desoxyribonucleic acid or its constituent nucleosides, whereas the Shorb titrimetric assay shows LLD activity for these substances. Cup and titrimetric assays show somewhat different responses to modified substances, such as vitamin B_{12a}, when assayed against a vitamin B_{12} standard. Impure materials, containing various LLD-active substances, do not necessarily yield equal results by both methods. Shorb's liver concentrate standard, assigned a value of 1,000 LLD units per mg, from which the above-noted LLD activity of B_{12} was determined by titrimetric assay, was found experimentally to contain 1,120 units/mg by the cup assay with crystalline vitamin B_{12} standard.

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Note: Description of a cup assay for the antipernicious anemia factor, in which thymidine and related compounds caused interference, was presented orally by Dr. W. F. J. Cuthbertson before the Biochemistry Society in London, January 22, 1949.

Aureomycin in the Cultivation of *Endamoeba histolytica*[1]

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Three attempts have been made to establish a single strain of *Endamoeba histolytica* in Shaffer-Frye medium (*3*) containing aureomycin in place of other antibiotics. The aureomycin (Duomycin) was obtained from Lederle Laboratories in vials each containing 50 mg of powdered aureomycin. This was diluted in a phosphate buffer, pH 6.9, and used within 2 hr. Final concentrations of aureomycin in the culture tubes ranged from a dilution of 1:1,000 to 1:5,000,000.

In each experiment the inoculum used consisted of 48-hr cultures of the amebae collected in large numbers by centrifuging the buffered saline overlay containing rice starch from flasks of coagulated egg base (*2*). These flasks were inoculated with amebae from Balamuth's culture medium (*1*). Counts were made on the material inoculated into the aureomycin cultures, and a volume of 0.5 ml was inoculated into each tube. Growth of the amebae in culture was estimated by examining them through the wall of the test tube placed under the 16-mm objective of the microscope and recording the relative numbers in terms of 0, ±, +, ++, +++, or ++++.

In the first attempt to establish our human strain XXII in the aureomycin cultures, five dilutions of aureomycin were used with two tubes for each dilution, and four control tubes were set up, two having 10,000 units of streptomycin and 5,000 units of penicillin in 0.5 ml of buffered saline, and two having the same amounts of streptomycin and penicillin in 0.2 ml of physiological saline. The aureomycin dilutions used were 1:1,000, 1:2,000, 1:10,000, 1:100,000, and 1:1,000,000. Transfers of the cultures were made at 48- or 72-hr intervals.

In this first experiment, positive cultures were obtained only in the tubes containing aureomycin diluted 1:100,000 and 1:1,000,000, and in the controls. The two 48-hr cultures of 1:1,000,000 dilution (++++ growth) were pooled and from them tubes containing aureomycin diluted 1:33,000, 1:50,000, 1:1,000,000, and 1:2,000,000 were inoculated. Growth was obtained in all dilutions, but it was decidedly better in the 1:1,000,000 and 1:2,000,000 than in the lower dilutions. The two tubes containing the 1:33,333 dilution remained positive only 48 hr and those containing 1:50,000 remained positive 72–96 hr. One tube containing 1:2,000,000 was positive 168 hr after inoculation. A third passage was made 72 hr after the previous transfer and positive cultures in dilutions of 1:50,000, 1:100,000 (inoculum 120 hr old), 1:1,000,000, and 1:2,000,000 were transferred. Only two tubes became positive for amebae and they had a ± rating 48 hr after inoculation. After the third transfer the

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[1] Supported by a grant-in-aid from the National Institutes of Health, Bethesda, Md. Thanks are due Dr. Herald Cox, Lederle Laboratories, Pearl River, N. Y., for furnishing supplies of aureomycin and important data on its properties.

control tubes also were negative except for one ± tube 24 hr after inoculation.

In this first attempt to establish the amebae in aureomycin cultures, the tubes containing aureomycin dilutions of 1:1,000 and 1:2,000 were clear but decidedly yellow, due to the high concentration of aureomycin. The other tubes were moderately turbid and became increasingly so with age. After the second transfer all tubes were considerably less turbid than before, but did not become perfectly clear until after the third transfer. When the third passage was made, tubes of brain heart infusion and thioglycolate media were inoculated with the amebic cultures to test for living bacteria. The tubes inoculated from the control cultures remained clear (presumably negative for bacterial growth) for 96 hr, when they were discarded. The tubes inoculated from the aureomycin cultures all became cloudy (positive for bacterial growth), but the inocula containing aureomycin dilutions of 1:33,333 and 1:50,000 showed slower growth of bacteria than did those in dilutions of 1:100,000 and higher.

In a second attempt to establish the amebae in aureomycin cultures, this antibiotic was used in six dilutions: 1:33,333, 1:100,000, 1:333,333, 1:1,000,000, 1:2,000,000, and 1:5,000,000. Four controls with streptomycin and penicillin were set up as before. The first passage of the amebae into the aureomycin medium resulted in positive cultures in all dilutions, but the 1:33,333 dilution was negative after 48 hr. Growth in the 1:100,000 dilution was best at 24 hr and decreased steadily thereafter, while in all the higher dilutions ++++ growth was recorded after 48 hr. All tubes were quite turbid in 24 hr, the 1:5,000,000 dilution having the greatest turbidity.

In this experiment the amebae were maintained through five serial passages made at 48-hr intervals. In one set of tubes, transfer of the amebae was made into tubes containg the same dilution of aureomycin as previously, while in a second set the positive cultures remaining after the third passage were transferred into media containing the next highest dilution of aureomycin in series. In this second set of cultures, four tubes were inoculated containing aureomycin in dilutions of 1:333,333, 1:1,000,000, 1:2,000,000, and 1:5,000,000. The last dilution was turbid in 24 hr and did not become positive for amebae, while the other three cultures were positive after 24–48 hr but were very poor and showed gas production. The four cultures were transferred one more time into the same aureomycin dilutions but only one tube showed growth, the 1:2,000,000, which remained ± for 72 hr before becoming negative.

In the series of cultures which were transferred into the same dilutions of aureomycin, the amebae in the dilution of 1:33,333 did not survive a second passage. The amebae in the 1:100,000 dilution survived four passages before dying out, but did not grow quite as well as those in the higher dilutions. In the 1:333,333 dilution, the amebae grew quite well at first but died out after the fourth passage. Amebae in the dilution of 1: 1,000,000 remained positive through five passages when they were discontinued, since growth at that time was very poor. After the second passage, the tubes having the 1:5,000,000 dilution of aureomycin became very turbid, and the 1: 2,000,000 dilution increased in turbidity. Gas production was evident in the 1: 2,000,000 tubes after the third passage, in the 1:1,000,000 and 1:333,333 tubes after the fourth passage, and in the 1:100,000 tube after the fifth passage. In the control cultures with this series, only two of the four survived the third passage, one the fourth, and none the fifth.

A third attempt was made to establish the amebae in aureomycin cultures, starting this time with four dilutions: 1:100,000, 1:500,000, 1:1,000,000, and 1:2,000,000. Only two controls were run, using 10,000 units of streptomycin and 5,000 units of penicillin in 0.5 ml of buffered saline. The control tubes were negative for amebae after the third passage, and were discontinued. Six serial passages were made with the aureomycin cultures, and the only one which survived them all was the 1:1,000,000 dilution, which became negative 48 hr after the last transfer. The growth of the amebae was poorer in the 1:100,000 dilution than in the higher dilutions and became negative earlier, surviving only four passages. There was little difference in the amount of growth obtained in the other three dilutions; however, the 1:2,000,000 dilution had a tendency to become turbid when kept four or five days. Gas production was never eliminated from those tubes in which the amebae grew.

As in the second experiment, these cultures were transferred following the first passage to media containing the next higher dilution of aureomycin and maintained in the decreased aureomycin concentration. There was no significant difference in the growth or survival of amebae in the dilutions of 1:500,000, 1:1,000,000, and 1:2,000,000; however, when the amebae in 1:2,000,000 were put into a dilution of 1:4,000,000, the medium became so turbid that this dilution was not continued. In the other three dilutions, the amebae survived four and five serial passages.

From the experiments described it seems that there is an optimum range of aureomycin concentration for the growth of *E. histolytica*. Too high a concentration, or a dilution of less than 1: 100,000, appears to inhibit amebic growth, either directly or indirectly, although bacterial growth may be checked or inhibited. Too great a dilution, 1:2,000,000 or more, is insufficient to control bacterial growth and therefore unsatisfactory as a substitute for penicillin and streptomycin. Within a certain range, possibly 1:300,000 up to 1:1,000,000, the amebae grew well but there was evidence that bacterial growth was not inhibited. On the basis of these experiments, it would appear that the strain of amebae tested grows in the aureomycin cultures as well as, if not better than, in the penicillin-streptomycin cultures, although control of bacterial flora was less satisfactory.

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Comments and Communications

The Structure and Activity Relationships of the Choline Group of Drugs Determined by Measurements of Phase-Boundary Potential

The interesting paper of Ing (*Science*, 1949, 109, 264) presents data exposing discrepancies in the proposal made by Pfeiffer that muscarinic action is produced by a spatial molecular configuration (*Science*, 1948, 107, 94). Both authors have pointed out pharmacologically important features of the structural formulas of cholinergic substances but no mention is made of the lipoid solubility or electrogenic properties of the compounds described.

Twenty years ago, the senior author (Beutner, R., *J. Pharm. exp. Therap.*, 1927, 31, 305) reported the outstanding phase-boundary potential of alkaloids and recently the transient potentials (waves) of acetylcholine were described (Seventeenth International Congress of Physiology, Abstracts of Communications, p. 390, 1947; Second International Congress of Electroencephalography, Paris, 1949). These investigations of the essential or electrical action of cholinergic drugs show that pharmacodynamics must deal with energy relationships and attempt to discover the mechanism underlying the relation of structure to action. We have measured the phase-boundary potentials of choline and acetylcholine and also determined the ohmic resistance of the oils shaken with choline and acetylcholine. Acetylcholine chloride, at a concentration of 0.0027 M, produced 35 mv negativity at the interface between saline and guaiacol, reducing the resistance from 2.4×10^6 to 2.7×10^5 ohms. In the same apparatus, 0.0027 M choline chloride produced only 5 mv negativity, and reduced the resistance of the oil from 2.4×10^6 to 8.0×10^5 ohms.

These data throw light on the mechanism of action of this type of drug. Acetylcholine is a stronger cholinergic drug because it penetrates into the lipoid, and because after penetration it ionizes in the nonaqueous phase. For these reasons there is a higher ion concentration in the lipoid at the site of contact with acetylcholine. This in turn entails a larger negative potential at the lipoid surface. Such a variation is the essential factor in nerve activity. Changes in these physical properties are produced by the introduction of acetyl groups in choline, as our data show. Ing assigns special significance to the size of the ''cationic head'' of a cholinergic drug and to the charge on the N- atom. Without doubting the justification for these assumptions, we believe that these are factors influencing ionization in the lipoid phase and consequently of secondary importance for the pharmacological effect. The influence of the exchange of ethyl for methyl groups in acetylcholine would likewise exert pharmacological effect primarily through influence on the electrogenic properties of acetylcholine, and this holds also for other substitutions.

We agree with Ing that the term *prosthetic* applies to the acetyl group. In conclusion, it would appear that the ''cationic head'' of Ing, the ''prosthetic groups'' of Pfeiffer, and the ''positive charge on the central nitrogen'' of Taylor (*Nature*, 1947, 159, 86) are nothing more than ionization factors in the phase-boundary potentials of alkaloids previously described (cf. Beutner 1927).

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Geological Applications of Short Range, Two-Way Radio Sets

Recent success with portable, short range, two-way radio sets (''walkie-talkie'') in instruction of students in field geology suggests many possible applications of this or similar devices in educational and professional work.

The short range two-way radio, designed for voice conversation, is described in the War Department's Technical Manual No. 11-235, May 14, 1943, pp. 2–4 as a press-to-talk, portable, radio telephone, receiving and transmitting on the same frequency. The total weight of the set, including batteries, is 5.5 lb. The radio receiver is battery-powered; batteries should last about 15 hr under almost continuous operation.

Graduate field courses in geology, conducted as a part of the regular curriculum of class work at Louisiana State University, have for some time posed a problem in how to instruct these students properly in the field. These classes, in many instances, travel long distances between individual outcrops or type areas. Geologic and geomorphic features of considerable importance in student training often are present between such localities. In order to provide properly trained personnel for each car participating in these class trips, the enrollment previously has been restricted to a number sufficient to fill two cars. The increased graduate enrollment of the last few years, and the consequent increased demand for this type of course, has resulted in classes too large for proper instruction.

Recently, the technique of equipping each car with a portable, short range, two-way radio set was tried. Six cars and 24 students participated. One staff member, acting as trip leader, rode in the lead car; by means of the radio telephone he gave directions and instructions, and kept up intermittent discussions of various features encountered between the individual stops.

Signals for communication between cars were given by white flags or horns. In areas of sufficient interest, sets were kept on constantly; otherwise they were shut off until flags signaling communication were flown.

To overcome shielding and absorbing of signals by the metals in the car, aerials were extended outside the cars at all times during communication. For similar reasons, it was necessary to prevent contact of the aerial with the metals of the car.

The considerable success attained with this technique in so large a group allows for similar and related uses in field parties of various kinds. Such applications can be applied easily to almost any type of field investigation or construction operation utilizing more than one man.

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Longevity of the Tropical American Toad, *Bufo marinus* L.

Though toads are known to live for many years, there are few published records detailing the methods under which longevity tests have been conducted. In the experiment described here the toads were confined in a cage 8 ft long, 4 ft wide, and 2 ft high. It was covered with strong, galvanized screen of 1/8-in. mesh, attached to a heavy framework of concrete posts. Iron sheeting, 1 ft wide, was imbedded vertically in the ground just inside the walls to a depth of 6 in. This was to prevent any possibility of toads' burrowing out. A strong door, provided with a padlock, was built in the top of the cage.

To get toads for the test, eggs were collected on May 26, 1933, from a reservoir near Honolulu, where a female *Bufo*, attended by a male, had been observed laying an egg string. Some of the eggs were placed in a pan of water and hatched on May 29. The larvae were given green algae and boiled rice, on which they thrived. Metamorphosis was completed by June 30 and the toadlets, measuring about 6 mm in length, were placed in the cage. The ground was kept wet, and the cage was partially shaded. A small brick-lined retreat was constructed in one corner. Quantities of ants were supplied for food at frequent intervals. Within a few weeks the toads had grown sufficiently to take larger insects, and by October 1, when they were 3 months old, they were from 2½ to 3 in. long and able to swallow almost any insect given them.

The experiment started with 26 toads. By the time they were 6 months old, when many of them had reached a length of 4 in., the problem of feeding them sufficient insects became acute. The population was thinned to nine toads, consisting of five females and four males. By setting appropriate traps, cockroaches were caught to feed the toads. Many hundreds of roaches were placed in the cage weekly. A large pan of water was also supplied, but none of the confined toads ever laid any eggs.

This experiment continued until May 14, 1949, when the last toad—a large female—died, after being under almost daily observation for 15 years, 10 months, and 13 days. She had consumed during her lifetime, according to our estimate, about 72,000 cockroaches. The other eight toads in the test had lived from 8½ to 14 years.

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Some Problems in Sensory Prosynthesis

There is at present a very considerable amount of interest in devices by which lost senses can be replaced or at least compensated for. At the Massachusetts Institute of Technology the authors have been working on a method of replacing hearing by tactile stimulation. In this method a sound is carried from a microphone to a bank of filters. The output of each of these filters, except possibly the low frequency stage, is rectified and used to modulate a low frequency carrier and the output of these carriers as well as of the possibly by-passed low frequency stage, is carried to a number of stimulators, which may be properly designed electrodes or may be electromagnetic vibrators resting on suitable points of the skin, such as the five fingers. This produces a pattern of stimulation which we have already proved by experimentation to possess a high degree of recognizability and which we hope ultimately to embody in a portable apparatus by which we expect that the totally deaf can participate in active speech.

In designing this apparatus we have first had to convince ourselves by the theory of the Vocoder that the amount of information which could be transmitted by this transmitter, on the basis of acoustical speech, was of sufficient magnitude to furnish an adequate basis for the understanding of words. We then worked on the principle that in using an inferior sense, such as touch, it was necessary to cut the incoming information to that which is semantically sufficient so as not to overload the receptors of the skin and prolong the learning period. In doing this we have had to transfer part of the cortical function of the ordinary hearing mechanism to an electrical system outside the body. The severe limitation of the amount of information which exists when one tries to transfer one of the cortical functions to an external machine should be a guiding principle in other sensory replacements, such as those for the blind.

It is most important in all such prosthetic apparatus that the patient should not separate the problem of active communication, such as speech, from that of passive communication, such as hearing. In the normal individual, speech is maintained at a high level only by the continual monitoring of the speaking person in which, at no time, is he unable to compare his own speech with that of others. This is equally important, or even more important, in artificial methods of communication such as we are devising. The portability of the apparatus is not an advantage, but it is a necessity.[1] Under these conditions, as we have already demonstrated experimentally, the patient immediately begins to improve the quality of his speech by comparison and his voice begins to lose its deaf-mute deadness.

We suggest these principles as a basis for further work in sensory replacement.

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[1] The importance of feedback in the learning process is discussed at length in the book *Cybernetics* by Norbert Wiener, published by John Wiley & Sons. The apparatus employed in the course of the research reported above is described in the December 15, 1948 *Quarterly Progress Report* of the Research Laboratory of Electronics, Massachusetts Institute of Technology.

Scientific Book Register

Bochner, S., and Chandrasekharan, K. *Fourier transforms.* Princeton, N. J.: Princeton Univ. Press; London: Geoffrey Cumberlege, Oxford Univ. Press, 1949. Pp. 219. $3.50.

Boies, Lawrence R. *et al. Fundamentals of otolaryngology: a textbook of ear, nose and throat diseases.* Philadelphia-London: W. B. Saunders, 1949. Pp. xv + 443. (Illustrated.) $6.50.

Davenport, Horace W. *The abc of acid-base chemistry: the elements of physiological blood-gas chemistry for medical students and physicians.* (2nd ed.) Chicago: Univ. Chicago Press, 1949. Pp. 78. (Illustrated.) $2.00.

Davis, Tenney L. (Ed.) *Chymia: annual studies in the history of chemistry.* (Vol. 2.) Philadelphia: Univ. Pennsylvania Press, 1949. Pp. x + 143. (Illustrated.) $4.00.

De Kruif, Paul. *Life among the doctors.* New York: Harcourt, Brace, 1949. Pp. 470. $4.75.

Field, Henry. *The anthropology of Iraq: the lower Euphrates-Tigris region.* (Part I, No. 2, Publ. 631). Chicago: Field Museum of Natural History, 1949. Pp. 227 + 426, plates 49 + 228. (Illustrated.) $5.00.

Flosdorf, Earl W. *Freeze-drying: drying by sublimation.* New York (18): Reinhold, 1949. Pp. vii + 280. (Illustrated.) $5.00.

Gmelin's Hanndbuch der Anorganischen Chemie. (8th ed., System No. 10-B, Selenium.) Clausthal-Zellerfeld, Germany: Gmelin-Verlag, GMBH, 1949. (U. S. distributor: Dimitri R. Stein, 105 Pinehurst Avenue, New York (33), N. Y.) Pp. xxviii + 195. (Illustrated.) $16.25.

Kloeffler, Royce Gerald, and Horrell, Maurice Wilson. *Basic electronics.* New York: John Wiley; London: Chapman & Hall, 1949. Pp. xi + 435. (Illustrated.) $5.00.

Mayall, R. Newton, and Mayall, Margaret L. *Skyshooting: hunting the stars with your camera.* New York: Ronald Press, 1949. Pp. xi + 174. (Illustrated.) $3.75.

Moore, Charlotte E. *Atomic energy levels: as derived from the analyses of optical spectra,* Vol. I, ^{1}H–^{23}V. (National Bureau of Standards Circular 467.) Washington 25, D. C.: Supt. of Documents, U. S. Govt. Prntng. Office, 1949. Pp. xliii + 309. $2.75.

Ordway, Samuel H., Jr. *A conservation handbook.* New York (16): Conservation Foundation, 1949. Pp. 76. $1.00 postpaid.

Palmer, Ralph S. *Maine birds.* (Bull. Museum of Comparative Zoology, Harvard College, Vol. 102.) Cambridge 38, Mass.: Museum of Comparative Zoology, 1949. Pp. 656. $5.00.

Rider, Paul R. *First-year mathematics for colleges.* New York: Macmillan, 1949. Pp. xv + 714. (Illustrated.) $5.00.

NEWS and Notes

Alexander Spoehr, curator of oceanic ethnology, has left for a year's anthropological research for the Chicago Natural History Museum on Saipan and the Marianas. The expedition is sponsored by the National Research Council, in cooperation with the Navy Department. Dr. Spoehr will study the cultural change among the natives of the islands and conduct excavations in the Marianas to determine how these islands were originally peopled.

Thomas J. Parmley, professor of physics at the University of Utah and consultant at the Radiation Laboratory of the University of California, has joined the staff of the x-ray laboratory, Atomic and Molecular Physics Division, National Bureau of Standards. Dr. Parmley will investigate methods for measurement of the intensity and special distribution of pulsed x-rays.

Grant Taylor, assistant dean of the Duke University Medical School, has been named deputy director of the Atomic Bomb Casualty Commission in Japan. Dr. Taylor, who is associate professor of pediatrics and bacteriology at Duke, has been granted a two-year leave of absence for the special assignment.

Roger S. Warner, who recently resigned as director of engineering for the Atomic Energy Commission, has joined the staff of Arthur D. Little, Inc., research and engineering organization of Cambridge, Massachusetts.

Henry C. Meadow, coordinator of industrial research at the University of Rochester, has been appointed executive secretary to Harvard University's Committee on Research and Development for Medicine and Health. The committee is charged with the responsibility of coordinating the appeals for support of research and advanced training in all branches of science related to medicine and health.

Thorkild Jacobsen, director of the Oriental Institute and dean of the Division of Social Sciences at the University of Chicago, left for Baghdad October 27 with Mrs. Jacobsen, to join the University of Chicago-University of Pennsylvania archaeological expedition in Iraq. The group will continue excavating begun 50 years ago in the ruins of Nippur, 100 miles south of Baghdad.

Thomas J. Kirwin, assistant director of the James Buchanan Brady

Foundation for Urology, New York Hospital, has been appointed professor of urology at New York Medical College and director of the Department of Urology, Flower and Fifth Avenue Hospital and Metropolitan Hospital.

Visitors

H. Heller, professor of pharmacology of the University of Bristol, and **Hans Selye**, professor of physiology at the University of Montreal, were guest speakers at the University of Texas Medical Branch, Galveston, November 4 and 8 respectively. Professor Heller discussed the influence of renal factors on blood pressure, and Professor Selye, the alarm reaction.

Recent visitors at the National Bureau of Standards were: **J. J. W. den Haan**, chief engineer, Philips Research Laboratories, Eindhoven, Netherlands; **Adrien Jaquerod**, director, Swiss Laboratory of Horological Research, Neuchâtel, Switzerland; **P. W. Kim**, director of Technique and Supply, Kyongsong Spinning Company, Ltd., Seoul, Korea; **O. H. C. Messner**, consulting engineer, Gut Rosenberg, Zurich, Switzerland; **Ralph B. Watts**, head of Science Department, Australian Missionary College, Cooranbong, N.S.W., Australia; **P. Alexander**, manager, Research Department, Wolsey Ltd., Leicester, England; **A. T. S. Babb**, senior physical chemist, J. Lyons and Company, Ltd., London.

Grants and Awards

The 1950 medal of the Industrial Research Institute will be presented next April to Frank B. Jewett, former president of the National Academy of Sciences and for many years vice president of American Telephone and Telegraph Company. . The medal is presented annually for "outstanding accomplishment in leadership or management of industrial research which contributes broadly to the development of industry or the public welfare."

Norman C. Melchior, assistant professor of biochemistry at the Stritch School of Medicine, Loyola University, Chicago, has been awarded a grant-in-aid from the Permanent Science Fund of the American Academy of Arts and Sciences for the study of metal-organic complex compounds.

The 1949 Nobel prize for medicine was awarded jointly to a Swiss and a Portuguese for their work with human and animal brains, the physics prize went to a Japanese-born professor at Columbia University, and the chemistry prize to a Canadian-born professor at the University of California.

Walter Rudolf Hess, 68, director of Zurich University's Physiological Institute, and *Antonio Caetano de Abreu Freire Egas Moniz*, 75, professor emeritus of neurology in the Faculty of Medicine of the University of Lisbon, shared the prize money for physiology and medicine. Dr. Hess, a specialist in the circulation of the blood and breathing, was recognized for his experiments on cats and dogs showing how certain parts of the brain control the organs of the body. Dr. Moniz received the award for his development of the surgical technique known as prefrontal lobotomy, for the treatment of schizophrenia and paranoia.

Hideki Yukawa, 42, visiting professor of theoretical physics at Columbia University since last September, won the physics prize "for his prediction of the existence of the meson (an elusive mass, heavier than the electron, which theoretically glues the atomic nucleus together), based upon his theory of nuclear forces." Dr. Yukawa was only 28 and a recent graduate at the University of Kyoto when he first predicted the existence of the meson.

William Francis Giauque, 54, professor of thermodynamics at the University of California, received the prize in chemistry "for his contribution to chemical thermodynamics, especially for his investigations of the properties of substances at extremely low temperatures." Through Dr. Giauque's methods, temperatures have been pushed within a few thousandths of a degree Kelvin of absolute zero.

The Nobel prizes, which have been awarded annually since 1901, will be presented at a ceremony in Stockholm on December 10. The peace prize will go to Lord Boyd Orr, as reported in *Science* October 28. No prize in literature will be awarded this year.

The Research Corporation has awarded a grant to Martin B. Williamson, assistant professor of biochemistry at the Stritch School of Medicine, Loyola University, Chicago, for the study of the chemical structure of proteins.

Colleges and Universities

The Saint Louis University Department of Biology has inaugurated a program of graduate research leading to advanced degrees in Arctic biology. In addition to laboratory research, the program will include field work in Alaska, under the direction of Charles G. Wilber, head of the department. A grant of $9,000 from the U. S. Air Force will assist the program.

University of Rochester scientists have developed a new motion picture camera lens made from artificial sapphire which has several advantages over optical glass lenses. Its extreme hardness makes it almost impossible to scratch, and its high refractive index, which changes very little with the color of the light, improves the sharpness and quality of the images produced.

Meetings and Elections

At their recent meeting at Woods Hole, Massachusetts, the **Atlantic Fisheries Biologists** elected William R. Martin and Frank D. McCracken of the Fisheries Research Board of Canada, St. Andrews, New Brunswick, as president and secretary-treasurer respectively.

The American Chemical Society will hold its 16th annual chemical engineering symposium in Columbus, Ohio, December 29 and 30 at the Ohio State University. The symposium, which will be under the direction of a committee headed by E. W. Thiele, of the Standard Oil

Company, will deal with every aspect of material transfer between a gas and liquid phase, or between two liquid phases. J. H. Rushton, of the Illinois Institute of Technology, is chairman of the technical program.

An International Colloquium on Adsorption and Heterogenous Kinetics, sponsored by the French National Center of Scientific Research, was held at the University of Lyon, France, September 12–17. The meeting was organized by Marcel Prettre, head of the Department of Industrial Chemistry of the University of Lyon, and was attended by about eighty scientists from various countries including the United States, Great Britain, Austria, Belgium, Holland, Australia, and France.

Visiting scientists who presented papers at the meeting were H. S. Taylor (Princeton) and P. H. Emmett (Mellon Institute); R. M. Barrer (Aberdeen), S. R. Craxford (British Fuels Research Laboratory), B. M. W. Trapnell (Royal Institute), and A. R. Ubbelohde (Belfast); J. Jungers and E. Mertens (Louvain); C. Herbo (Brussels); H. Forestier (Strasbourg); and E. Cremer (Innsbruck). French scientists participating included M. Prettre, R. Bernard, C. Courty, M. Perrin, Y. Eyraud, J. Saulaville, P. Besson, S. Teichner, A. Troesch, P. Cornuault, E. Pernoux, and Y. Trambouze (Lyon); N. Bauer, M. Magat, M. Haissinsky, J. M. Dunoyer, M. Mathieu, M. Mering, J. Longuet-Escard, J. Escard, and Miss F. Fouinat (Paris); A. Michel (Lille); G. Valensi (Poitiers); and A. Guillemin, J. Vincent-Genod, J. Givaudon, E. Nagelstein, and R. Leygonie (French Petroleum Institute at Paris). In addition to those mentioned above, a number of visiting scientists from England, Holland, Belgium, and France took part in the discussions. In this group were C. Kemball, of Cambridge University, and the well-known catalytic chemist, L. Andrussow.

The meeting was opened by addresses of welcome by Prof. Douin, dean of the Faculty of Science at the university and by Prof. Prettre. At the same time M. Magat, who acted as official interpreter, was introduced to the colloquium. Prof. Magat, with his fluent command of French, English, and German and his well-founded and broad grasp of modern physical chemistry, contributed greatly to the success of the conference by his rapid and accurate translation of all discussions into French and English.

An interesting program of some forty papers that followed was divided into three main groups dealing with (1) the physical and chemical adsorption of gases by solids, (2) the texture and structure of catalyst surfaces as revealed by x-ray, adsorptive, electron microscopic, and magnetic techniques, and (3) the theoretical and experimental study of heterogenous kinetics of gas-solid and liquid-solid systems. According to present plans all of the contributed papers, together with the discussions, are to be published in a future issue of one of the French journals; accordingly, further details of the program will not be presented here.

The warm hospitality of the French hosts made the meeting especially pleasant for the visiting scientists. At the start of the meeting they were welcomed by a reception at the Hotel de Ville by a representative of M. Herriot, mayor of Lyon, and former prime minister of France. Throughout the week a series of luncheons and dinners gave all of us a chance to praise the excellent cuisine for which Lyon is noted and at the same time afforded an opportunity to discuss informally many matters of mutual interest.

PAUL H. EMMETT

An International Colloquium on Macromolecules was held September 1–5 in Amsterdam, Holland. The meeting, organized by Hermans, Koenigsberger, Overbeek, and Staverman had been very well prepared (all participants received a complete set of preprints about three weeks before its start) and gave an excellent cross section through recent progress in polymer kinetics and in the statistical treatment of macromolecules in solution. A number of papers on polycondensation, radical, cationic and anionic catalyzed addition polymerizations (by Champetier, Evans, Magat, and Melville) demonstrated that the kinetics of the formation of macromolecules under very widely varying conditions is beginning to be understood in a quantitative way. The trend now seems to be to apply the present results to arrive also at a quantitative control of copolymerization and to find ways and means to synthesize macromolecules of still higher molecular weights.

Particular interest was shown in several papers, by Eirich, Hermans, and Putzeys, on the statistical treatment of coiled macromolecules in solution and on the scattering of light by them. A series of contributions by Katchalsky, Künzle, and Overbeek was devoted to polyelectrolytes, with special emphasis on the significance of this branch of polymer science for the chemistry of proteins.

The level of all presentations was remarkably high; there was plenty of time for discussion and excellent use was made of it. On several fundamental points there was definite disagreement between the leading contributors, which resulted in animated discussions and arguments. The spirit and the stimulating effect of this colloquium were reminiscent of High Polymer Week at the Gordon Conference in Colby College. A volume containing all presentations and discussion remarks is scheduled to appear in about three or four months.

H. MARK

Conference on the Gene. A conference for examination of current developments and trends in studies of the gene was held at Shelter Island from May 30 to June 2 under the sponsorship of the National Academy of Sciences. The group of 20 participants included well-established geneticists and younger workers in the field. Free and informal discussion characterized the meetings, and provided an atmosphere conducive to critical examination of various aspects of the gene problem. The topics discussed included the mechanism of reverse mutation, the nature of allelism, the gene-enzyme relationship, the evidence for recombination in bacteria and bacteriophages, the role of the cytoplasm in heredity, and the chemical nature of chromosomal materials. There was general agreement among participants that these meetings in a quiet and congenial atmosphere provided opportunities such as are rarely encountered in large, formal meetings, for critical evaluation and integration of genetic studies on a variety of organisms. In the opinion of the participants, the conference exerted a directional influence that will be reflected in future studies of gene structure and function.

BERWIND P. KAUFMAN

A symposium in plasma proteins was held at the University of Illinois College of Medicine September 23–24, under the sponsorship of the Robert Gould Research Foundation of Cincinnati. Eighteen papers were presented by investigators engaged in research in this field in one afternoon and two morning sessions. Junior associates of the speakers were present as guests of the Robert Gould Research Foundation. At the evening session a motion picture was shown by E. V. McCollum, and an address given by Hugues Gounelle of Paris, on some of the unexpected observations during years of underfeeding in France.

Although the subject of the symposium was plasma proteins, the consideration of the subject was purposely so broad that the program included papers dealing with fundamental aspects of protein metabolism which might not ordinarily be considered as falling within the implications of such a title. The program was built around the principal topics of formation, dietary relationships, fractionation of plasma proteins, immunologic relationship, relation to the liver, hypoproteinemia, tracer isotope studies in relation to the plasma proteins, endocrine relationships, and amino acid competitors. Sidney C. Madden spoke on plasma protein formation in disease states and Irving M. London on studies of rates of turnover of plasma protein in man. Fractionation and some of the interactions of the plasma protein were presented by J. L. Oncley, and a discussion of the binding properties of serum proteins for small molecules by S. H. Armstrong, Jr. Tracer and isotope studies included papers by David Shemin on aspects on the biosynthesis of amino acid and proteins, and by Paul C. Zamecnik and Ivan D. Frantz, Jr. on the use of C^{14}-labeled amino acid in the study of peptide bond synthesis. The effect of dietary proteins on synthesis and relations between diet protein stores and plasma protein were presented by Bacon F. Chow and James B. Allison. Hypoproteinemia, particularly in relation to protein starvation in man and its clinical relationships, was discussed by Robert Elman and experimental studies of protein deficiency and temperature in relation to the formation of edema by M. Hegsted. Studies of the fate of intravenously injected plasma albumin were described by Fuller Albright and its metabolism in normal and undernourished individuals by Charles S. Davidson. Clinical studies of the relation of proteins to nutritional edema were presented by Dr. Gounelle. Certain immunological aspects of the plasma proteins were presented by Paul R. Cannon and Michael Heidelberger, and the effect of adrenal cortex on plasma protein formation and utilization and the physiological properties of amino acid antagonists were given by Abraham White and Karl Dittman respectively. Discussion followed each session. The papers will be made available later as a monograph.

JOHN B. YOUMANS

A thriving scarlet ibis colony has been discovered in Venezuela by Paul A. Zahl, New York ornithologist, who, under the sponsorship of the National Geographic Society, has been searching Venezuela's inland river system for the bird's breeding ground (see *Science*, Sept. 16, p. 289). The rookery lies some 125 miles west of San Fernando and covers an area about half a mile long and a quarter-mile wide, on a nearly inaccessible flood plain. "From a distance," Dr. Zahl stated, "its foliage looks as though it were laden densely with blood-red fruit." He estimates the number of adult scarlet ibis at about 5,000.

Recently Received—

List of Publications, U. S. Forest Products Laboratory, January 1–June 30, 1949. Madison 5, Wisconsin.

Some Lower Huronian Stromatolites of Northern Michigan. Eugene S. Richardson, Jr. Fieldiana—Geology, Vol. 10, No. 8. Chicago Natural History Museum.

Medical Mission to Poland and Finland, July 1–August 27, 1948. Abridged report, submitted by Erwin Kohn. Unitarian Service Committee, Inc., 9 Park Street, Boston 8.

Committee on Public Health Relations: A Summary Report of Activities for the Year 1948. New York Academy of Medicine, 2 E. 103 Street, New York 29.

Wissenschaft und Weltbild. January 1949. (Issued quarterly.) Verlag Herold, Vienna.

Second Notice on AAAS Meeting

There are still plenty of New York hotel rooms for the week of the Association's meeting, December 26–31, but early indications of a shortage of single rooms were justified. Miss Sylvia T. Peltonen, Manager, Housing Bureau, New York Convention and Visitors Bureau, 500 Park Avenue, New York 22, who is in charge of room assignments, reported that she had made reservations for the following number of persons, as of November 7:

Statler	691
New Yorker	120
McAlpin	412
Governor Clinton	192
Martinique	195

The Martinique is now completely booked; the Statler has no more *single* rooms. Take advantage of double rooms and make your reservations in parties of two or more if possible. If all Penn Zone hotels should fill up there are excellent hotels nearby, with the same price range.

Psychology and Scientific Research. III. The Transactional View in Psychological Research

Hadley Cantril, Adelbert Ames, Jr., Albert H. Hastorf, and William H. Ittelson

Princeton University, Princeton, New Jersey,
Hanover Institute, Hanover, New Hampshire, and
Dartmouth College, Hanover, New Hampshire

WHEN PSYCHOLOGY EMANCIPATES ITSELF from dependence on interactionism alone by taking a transactional view of the phenomena which come within its province, we should expect that the division of psychologists into schools would rapidly disappear. Schools (Gestalt, behaviorism, psychoanalysis, etc.) would disappear not because they are "wrong" or "have been overthrown" but because the formulations of each school that meet empirical tests would be encompassed within wider formulations of problems. What are some ways to speed this development?

First of all, the psychologist must not only realize intellectually, but must make a part of his functional assumptive world, the idea that man's thought and behavior can be understood only as processes of a "full situation of organism-environment." The point has been made by H. A. Murray and collaborators in their contention that "the main body of psychology started its career by putting the wrong foot forward and it has been out of step with the march of science much of the time. Instead of beginning with studies of the whole person adjusting to a natural environment, it began with studies of a segment of a person responding to a physical stimulus in an unnatural laboratory environment" (*10*, 466). Brunswik, in his "ecological analysis," has pointed out the need to understand the complete "representativeness of circumstances" operative in any situation under observation (*2*). But while an increasing number of psychologists are calling for a revision in traditional psychological procedure, their voices are still those of men crying in the wilderness of the universe which constitutes so much of psychological inquiry today. The psychological investigator, of all people, cannot separate the observer from what is being observed, the process of knowing from what is known, what is "out there" from whatever goes on in the experiencing organism. Psychology must disavow completely any "field theory" which implies that an environmental field acts *on* a person rather than *through* a person.

Because man inevitably builds up for himself an assumptive world in carrying out his purposive activities, the world he is related to, the world he sees, the world he is operating on, and the world that is operating on him is the result of a transactional process in which man himself plays an active role. Man carries out his activities in the midst of concrete events which themselves delimit the significances he must deal with.

In the process man is himself changed in greater or lesser degree by having his own assumptive world changed through confirmation or denial as a result of action. In his immediate activity man abstracts from the immediate situation certain determined aspects according to his assumptive world. And this, as we indicated, includes far more than the immediate occasion: it is a continuum which includes the past and the future, a storehouse of both past experience and ideals. As Bentley has pointed out, "Behaviors are present events converging pasts into futures. They cannot be reduced to successions of instants nor to successions of locations. They themselves span extension and duration. The pasts and the futures are rather phases of behavior than its control" (*1*, 485). Psychologists must be constantly aware of the effects man's own actions have both on his assumptive world—confirming or denying certain aspects of it—and concurrently on the "environment out there" as it is perceived and experienced.

Another implication of the transactional mode of observation is that the psychologist, like any other scientific investigator, must be sensitive to the pitfalls involved in reifying anything as an entity that has been given a proper name—a pitfall that philosophers since Plato have inveighed against. Psychologists, like other scientists, must become increasingly self-conscious of the dangers to their scientific progress inherent in catchwords, whose use, as Dewey and Bentley point out, "shatters the subject matter into fragments in advance of inquiry and thus destroys instead of furthering comprehensive observation for it" (*6*, 243). Any uncritical use of traditional abstractions makes it difficult or impossible to see together what has already been taken apart.

While academic psychologists have long since given up the entity of the *soul*, and while most of them, at least in their professional writing, refuse to talk of the *mind*,[1] many other entities have slipped into the professional jargon of psychology to make transactional observation difficult. We have, for example, *need*, *I. Q.*, *schizophrenic*, *trait*, *attitude*, *Oedipus complex*, and *mesomorph*. The uncritical use of such words as specifications can easily lead to redundancy and double talk.

Psychology runs the risk of retarding its discovery of new bases for psychological standards through the use of bases for standards employed successfully in the past by the physical sciences. For example, psychologists refer to "the size of the retinal image," "visual angles," "intensity of opinion," "field forces," "gradients," "positive or negative valences," "vectors," "depth psychology," and some even search for the physical dimensions of consciousness, limiting physical dimensions to a handful of constructs. Psychology has by no means emancipated itself yet from the standards of the physical sciences and is not rapidly enough discovering standards appropriate for the phenomena with which it deals.[2] By refusing to place firm reliance on standards whose bases are necessarily subjective, psychology sometimes complacently throws out some of the most important problems with which it should be concerned. Nouns such as *surety*, *anxiety*, *ego-involvement*, *expectancy*, *happiness*, imply adjectival or adverbial relationships that are purely subjective. There are plenty of bases available for standards if the psychologist dares use them as he becomes sensitive to the importance of the problem of selecting bases for standards appropriate for the inquiry at hand.

It has become increasingly clear in recent years in the fields of chemistry and biology, for example, that standards appropriate to the subject matter of investigation must be sought and that reliance on the standards of classical or modern physics alone will hamper investigation. For example, J. G. Hoffman, a professor of biophysics, has recently noted that "the word biophysics . . . is a ridiculous combination of incongruous extremes. Disciplined scientific thought has never taken more diverse forms than it has in the fundamental modes of thinking in biology and in physics" (*8*, 7). In pointing out the limitations of a physical mode of observation for the study of living systems, Hoffman quotes Delbrück's statement that "instead of aiming at the whole of the phenomena exhibited by the living cell we now expect to find natural limits and, thereby, implicitly, new virgin territories, on which laws may hold which are independent of those of physics, by virtue of the fact that they relate to phenomena whose appearance is conditioned on *not* making observations of the type needed for applying atomic physics" (*8*, 14).

There is also a tendency in psychology to use catchwords in labeling the fields of social, clinical, educational, or industrial as "applied" fields of psychology and to separate them from the more traditional "experimental" psychology. Any such division is absurd unless the person who uses it consciously reserves it for rough descriptive purposes. Investigators in these fields must, of course, also rely on experiments. But beyond that, any such distinction acts as a deterrent in the search for more adequate formulations which will better account for human behavior, whether in the laboratory, the clinic, the factory or in everyday social life. It is especially in fields such as these that one encounters hitches in interpretation because of the huge number of variables involved in the concrete situations that constitute each of the areas of inquiry. When such hitches are encountered, the investigator does not merely "apply" to their resolution some theory he has read in a book or learned from laboratory experiments. To be sure, he brings such knowledge and experience into the process of hypothesis formation. But the chances are very high indeed that any theory which is not itself based in large part upon the understanding of similar full-bodied concrete situations will turn out to be extremely inadequate.

We can illustrate the way in which psychological inquiry has been restricted by the use of terms with reference to the field of perception, which has so often been a weathervane in psychology. In working on perception, psychologists early found that certain variations in objective or physiological factors produced marked subjective variations. This naturally led to the idea of correspondence between subjective factors on the one hand and objective and physiological factors on the other hand. Since an alteration of objective and physiological factors could so easily be shown to cause subjective effects and since the converse could not so easily be demonstrated, the assumption was built up that the subjective aspects of perception had their origin largely in the corresponding objective factors and the accompanying physiological disturbances they caused. Studies of perception have thus concentrated largely on the analysis of objective and physiological factors. And since these objective or physiological factors could be varied quantitatively, scientific methodology in psychology tended to become identified with measurement alone.

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[1] A good example of a scientist who used the transactional method of observation was G. E. Coghill, who taught himself to see every organism in terms of a manifold of three inseparable constituents—structure, function, and mentation. The word *mentation* Coghill used as a substitute for *mind*, to connote the constant organism-environment transaction (7, 198).

[2] It is significant that psychological terms describing capacities of human beings are occasionally used by natural scientists as rough specifications of certain phenomena they encounter. For example, mathematical physicists, in describing the behavior of some of their electronic computing machines when they become overloaded, call them "neurotic"; while biologists occasionally speak of the phenomenal "memory" which the cells of the body exhibit for certain stimuli.

This led to a long neglect of those factors not amenable to precise measurement. These neglected factors were, of course, subjective factors described by such symbols as past experience, loyalties, expectancy, and purpose, whether these were operating consciously or unconsciously. This methodological dam has recently been cracked, largely through research in social and clinical psychology, where the effects of subjective factors on perception are especially obvious. More recently, in an attempt to liberate investigators somewhat from correspondence between subjective and objective or physiological factors, the Hanover Institute has designed demonstrations of perceptual phenomena which deliberately make use of illusions. By using illusions, the investigator gains more freedom to understand the nature of the functional activities that are involved in the scientific inquiry of perception and thereby gets a better toehold on the function of perception in man's purposive behavior. For example, it can be demonstrated that the perception of *where* a thing is depends upon the perception of *what* a thing is and on *when* it is perceived. Carr has pointed out that "illusions contrasted with correct perceptions are the experimental variants that reveal the common principle involved in both" (*4*, 326).

On the basis of an interactional view alone, an investigator could study the interdependence of various aspects of a perception forever and never get at the reason for such relationships until he asked himself what function such an interrelationship of phenomena served in the transaction of living. When he asks himself this question it appears that variables such as size and distance are experientially related because it is only through their relationship in past experiences that high prognostic reliability is built up. Prognostic reliability becomes itself, then, a new dimension of experience, a new basis for a standard the psychologist can use for experimentation. And if the investigator continues, as he must, to ask the next question concerning the function of prognostic reliability in a life transaction, the apparent answer is that prognostic reliability of a perception increases effective action. So the effectiveness of action becomes another variable that can be used as a basis for a standard in experimentation. And there must follow, of course, the question: Effective action for what? We then see that we cannot understand even the simplest perception without bringing in the variable of purpose.

The transactional mode of observation seems, then, to be peculiarly appropriate for psychologists if they are going to seek what Collingwood has called more abstract, more universal "logical grounds" for the understanding of subordinate abstractions or phenomena (*5*). Obviously, if we do not understand the logical ground that causes relevant variables to be relevant, then our scientific methods will be sterile indeed. Hence progress in psychology is to be measured largely in terms of the discovery of logical grounds which increase our understanding because of their intrinsic reasonableness and the possiblity they hold out of verification by experimental methods. Many of the abstractions Freud created are a case in point.

The transactional view has a third implication for psychology which concerns the method of experimentation that must be involved in real research. Different subjects for scientific inquiry pose different kinds of problems that can only be solved by adapting or creating methods appropriate to them. In saying that any one scientific discipline has special circumstances of its own which determine the techniques to be used, we are not in any way denying the indispensability of the universal characteristic of scientific method: the controlled experiment. All we are saying is that we must increase our self-consciousness and our ingenuity concerning the use and meaning of *controlled* and not claim that we are undertaking controlled scientific investigation when our assumptive world artificially limits the number of potential controls we are aware of.

One difficulty in the use of experimental techniques in psychology and the social sciences is that of approximating in a controlled experiment any concrete situation in which thought and behavior normally occur. Although this has been pointed out many times, and although the difficulty is easily recognizable, psychologists must be particularly on their guard to see that, in the experimental situations they devise, they have not left out so many of the subjective variables involved in normal experience that their experimental results will have little subsumptive power.

A second and much less frequently realized difficulty is that in dealing with the human organism we are dealing with a particular variety of "world stuff" which perceives complicated significances. Unless we make a special effort to understand the particular significance a particular organism at a particular time and place attaches to all the stimuli involved in our investigations, we shall again have abstracted out of the situation perhaps the most important variables for study. In psychology it is imperative that the investigator be as aware as possible of the unconscious assumptions brought by his subject to any experimental situation. Otherwise he will not have the slightest idea of what aspects of the phenomenon under investigation are most important. This awareness of assumptions is as important for the psychologist to have in mind in understanding the perception of a chair as it is in understanding social perceptions.

Still another difficulty facing the psychologist is the comparative lack of any agreed-upon bases for standards by means of which experimental situations can be described and repeated and results can be interpreted. The search for appropriate bases for standards is obviously one which requires great caution and wisdom in an area such as psychology because of the number of unknown variables apt to be involved in any standards set. Much careful research is still needed to discover what variables should be used as the bases for standards to provide the most useful analysis of man's experience.

VALUE JUDGMENTS AND "OBJECTIVITY"

A great deal of discussion has taken place in recent years concerning the possibility or the desirability of complete "objectivity" in science. The publication of Karl Pearson's *Grammar of science* in 1892, (*11*) with its contention that an understanding of scientific method can train "the mind to an exact and impartial analysis of facts" and can free the individual from bias in the formation of judgments gave a great boost to the myth that real scientific inquiry somehow goes on in a world devoid of personal judgments. The contrasting point of view has been expressed by Whitehead (*12*, 228 f.):

> Judgments of worth are no part of the texture of physical science, but they are part of the motive of its production. Mankind have raised the edifice of science, because they have judged it worth while. In other words, the motives involve innumerable judgments of value. Again, there has been conscious selection of the parts of the scientific fields to be cultivated, and this conscious selection involves judgments of value. These values may be aesthetic, or moral, or utilitarian, namely, judgments as to the beauty of the structure, or as to the duty of exploring the truth, or as to utility in the satisfaction of physical wants. But whatever the motive, without judgments of value there would have been no science.

It is becoming increasingly clear that the process of mentation involved in scientific inquiry is not a simple one of bringing "impartial analysis" to bear on a set of conditions. The scientist's own value-judgments are involved in (1) sensing the inadequacy of his conceptual structure—posing a problem for himself; (2) sensing the functional activities or subphenomena which may be involved in the phenomenon that has caused the original hitch; (3) deciding on which aspects of a phenomenon (variables) can fruitfully be used as bases for standards in experimentation; and (4) designing an experimental procedure to test the validity of these bases for standards. Scientific research thus involves an elaborate process of weighing and integrating which may take place largely on an unconscious level.

In this process, all of the unconscious assumptions, all of the awarenesses, and all of the conceptual abstractions of the individual investigator's assumptive world are operative. Whether any scientist likes to admit it or not, any interpretation he makes must be regarded as a value judgment. To be sure, rational thought and the conscious intellectual manipulation of abstracted variables can, often do, and obviously should, play a most important role in the process of scientific inquiry. But to assume that rational thought and conscious manipulation alone are the determinants of the judgments involved in scientific research is to go against the overwhelming evidence already obtained from scientific research itself. The dictionary definition of the word *objective*, in the sense it is used in discussions concerning the objectivity of science, is: "Emphasizing or expressing the nature of reality as it is apart from self-consciousness; treating events or phenomena as external rather than as affected by one's reflections or feelings." For example, our knowledge of perception, showing that "the nature of reality" as we experience it would not exist *except for* the assumptive world we bring to a concrete situation, flatly contradicts the contention that the scientist can be objective in any such sense.

The objectivity of science can therefore only refer to the use of accepted rules of empirical research *after* the problem, the variables, and the experimental design have been decided upon. Here the scientific investigator takes every precaution he can to see that he does not misinterpret what he observes by allowing any subjective bias to enter into the actual conduct of the experiment itself.

Not only is objectivity illusory in the sense of eliminating personal bias: it is also undesirable. We cannot improve on the conclusion reached by Herrick (*7*, 180 f.) after a lifetime of productive research in neurology:

> The bias which arises from unrecognized personal attitudes, interests, and preconceptions is the most treacherous of all the subversive enemies of sound scientific progress; yet these attitudes and interests are the key factors in all really original scientific investigation. This issue must be faced frankly and courageously. The easy way out is to ignore the troublesome personal ingredients of the problem and say that science has no concern with them. This is now generally regarded as the standard or normal scientific method. But actually this cannot be done, and we cannot afford to try to do it; for the interests and the attitudes of the inquirer shape the whole course of the investigation, without which it is meaningless and fruitless. To neglect these components of sci-

entific work and the satisfactions of a successful outcome is to sterilize not only the process but also the results of the inquiry. The vital germ of untrammeled imaginative thinking is thrown into the discard, and too often we seem quite content with the dead husk which is so easily weighed, measured, classified, and then stowed away in the warehouse.

In the social sciences, Robert Lynd has made the same point in his plea for "outrageous hypotheses" (*9*).

The myth that "science is objective" may tend to be fostered in most cultures today in an attempt to preserve whatever status quo exists by giving it scientific blessing. But any scientist will resent boundaries placed on his thinking by social, economic, political, religious, or any other ideological barriers and taboos. This danger is especially prevalent in the field of inquiry labeled "social psychology" and in the social sciences, where the data gathered have been largely determined and preconditioned by the purposes and conditions within which the investigator has worked.

Psychologists and social scientists who honestly try to bring their most mature value judgments to bear on concrete social problems are all too frequently labeled as biased, crackpot reformers if they even implicitly criticize existing social relationships. Yet it is because scientific inquiry is shot through with value judgments that no scientist can avoid some responsibility for the judgments he makes. And because value judgments play so important a role in scientific thinking, ways and means must be discovered of making value judgments themselves the subject matter for scientific inquiry (*3*). Value judgments concern the significance of the constant emergents which are not subject to explanation in determined and verifiable terms. Here the scientist has a freedom of choice; here conscience, the "sense of oughtness," must be recognized as the highest standard for effective action. When the subject matter with which the scientist deals consists of human beings trying to act effectively to carry out their purposes, then the social responsibility of anyone who pretends to be an expert obviously becomes very great indeed.

ACCELERATING RESEARCH IN PSYCHOLOGY

Our recurring theme has been that any truly scientific investigation involves much more than the use of an accepted methodology of experimentation. We have tried to show why the progress men hope for in their understanding of themselves can come about only to the extent that those who are professionally concerned with such an understanding become increasingly sensitive to the problem of problemization.

But readers already sympathetic with our emphasis may be reminded of the dramatic critic who, after pointing out the second-rate quality of then current productions, ended his comments with the statement that what we need are better plays. Are there any concrete suggestions which might speed up the search for more and more adequate formulations psychologists would seek to verify experimentally? A few have occurred to us.

We have pointed out that scientific inquiry, like any inquiry, begins when we meet a hitch, when we sense the limitations of or doubt the adequacy and reliability of our assumptive worlds as we try to act effectively. From this it follows that every attempt must be made to increase an investigator's consciousness of the range of hitches that must be faced and that are inherent in attempts to resolve problems. We must get across the notion that hitches are not obstacles to be avoided but, on the other hand, challenges which alone make productive research possible. No one can be "trained" to do research merely by having a set of rules spelled out for him. A good investigator, like a good clinician, a good advertising man, or a good labor leader, will be produced only when there is a real desire and ability to use ingenuity in meeting the hitches that occur in carrying out purposive action.

It has long been apparent that no one person today can be thoroughly competent, knowledgeable, and experienced in the diversified areas of inquiry that impinge on and are necessary for a proper understanding of man. More than mere cross-fertilization or broadened specialization is needed. Can ways and means be found to make it possible to bring together investigators who agree on the probable common significance of the hitches they face and on the probable order of importance of the hitches that must be resolved for improved understanding? Perhaps informal organizations are required which will make it possible for men of diverse experience to work and commune together as the occasion demands, on common problems and on the same level without reliance on one another's authority and unrestricted by limitations of time or any goal other than the search for more adequate concepts. Psychologists and social scientists will have to work out organizational and communicating techniques so their search for the more adequate conceptualizations people expect of them will not be hampered by formalities or administrative duties.

All investigators are caught in and influenced by a traditional mode of thinking and teaching cluttered up with catchwords, with an emphasis on the interaction of variables, with an overconcentration on methodology for its own sake. In academic circles the tendency all too often is to feel that the student—and the professor—have essentially "covered" the problem of formulation if various systems and theories of psychology have been reviewed. The psychologist's relative lack of concern with the problem of more adequately formulating emerging problems is often reflected in what seems to be his extreme self-consciousness in respect to the short history of his discipline.

We are not in the least denying, of course, that rigorous methodological standards must be insisted upon or that the history of the subject should be reviewed. But we do feel that progress in psychology can be brought about more rapidly only if methodological procedures are considered in relation to concrete problems and if the history of psychological investigations can be viewed from the perspective of problems that now seem significant, rather than vice versa. Whitehead has nicely stated both points in his dicta that "the main evidence a methodology is worn out comes when progress within it no longer deals with main issues" (*13*, 13) and that "a science which hesitates to forget its own history is lost" (*12*, 162).

(*This is the third of a series of three articles.*)

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The 112th Annual Meeting of the British Association for the Advancement of Science

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THE 112TH ANNUAL MEETING of the British Association for the Advancement of Science was held in the heavily industrialized northern England town of Newcastle-upon-Tyne, in the first week in September. Some 3,500 persons—scientists and science-minded citizens—were present.

This area has a great technological tradition, for—as Pierre Auger, head of Unesco's Natural Sciences Department, pointed out in an official address—"It was in this ancient city of Newcastle that the world-famous engineer George Stephenson, a century and a quarter ago, established the iron works where were built the first steam engines that went puffing into history between Stockton and Darlington, and Manchester and Liverpool—and began a new and splendid phase in industrial development."

The theme for this meeting was set by Sir John Russell, who devoted his presidential address to a review of the world's food and population problems. He pointed out that the present population of the world—2,300,000,000—was increasing by 20 millions a year. That meant an average addition of two every three seconds, day and night, year after year, and these two might become more as science advanced, social services improved, and international organizations became fully operative.

About 11 billion acres of the world are climatically suited to crop growth, he said: but of this area, only 3 to 4 billion acres are used—7 to 10 percent of the world's land surface—for both food and industrial crops. There is no need, however, for gloom. Science is continuously opening up new possibilities. For example, thyroxin, or iodated protein, fed to cows by mouth, can increase the fat content of milk and augment the yield by another 20 percent. Even more dramatic is the use of a synthetic estrogen (the female sex hormone) introduced under the skin, for inducing lactation in virgin heifers or barren cows. This is the first stage in making the male redundant.

Experiments with rabbits, Sir John pointed out, have shown that at some time in the near future a single pedigreed cow might produce 75,000 calves without undergoing the pangs of birth. The calves would come from "living incubators"—inferior cows in which an ovum had been transplanted from the pedigreed animal and then fertilized by artificial insemination. In this process, again, a bull might become all but obsolete.

Among other research results which have an immediate practical application, Sir John Russell mentioned:

The use of auxins. A spray of β-naphthoxyacetic acid, 40 parts per million of water, has been used by commercial growers of tomatoes and cucumbers to produce fruits normal in appearance but not yet in quality. They are seedless.

The work of R. Brown, of Leeds, and A. R. Todd, of Cambridge, on chemical stimulants and pests. They have found that the seeds of witchweed (*Striga*), a flowering plant that parasitizes sorghums and millets and is the cause of much loss in Africa and India, germinates only when stimulated by substances excreted from their roots. This substance is apparently a sugar. If the different varieties of sorghum should differ in their ability to prepare and excrete this stimulant, a chemical test might be devised that would greatly assist plant breeders searching for resistant strains. It is possible that other parasitic fungi could live only on varieties of plants capable of producing the necessary stimulant.

The fact that various soil organisms are known to produce antibiotic substances analogous to penicillin. For example, Thaysen and others have found in tropical soils bacteria with high powers of inhibiting the growth of fungi. In the absence of a good soil fungicide it is possible that soil-borne fungal diseases may be successfully controlled by introducing or encouraging organisms producing the appropriate antibiotic.

The subject of "Food and People" was discussed at a public meeting held under the chairmanship of Sir John Russell. Pierre Auger contrasted the eagerness with which Great Britain accepted the railway as a means of increasing the wealth and resources of mankind with the current doubt as to whether science should be regarded as a friend or the enemy of mankind. If man wishes, he can use science and technology to rid himself of illness and disease, and to remove the burden of unproductive and uneconomic toil. He gave details of the major experiment in mass enlightenment begun by Unesco, in an attempt to organize in many countries active discussion of this topic, with the object of focusing the attentions of the peoples of the world on this urgent problem. Unesco hopes to show not only the necessity for international cooperation in solving the problem, but also that such collaboration is already taking place at all levels among the existing international organizations.

Lord Horder said that he believed man could achieve such physical, chemical, and biological control of the earth as to enable him not only to adjust population to food, but also food to population. He warned, however, that food would not be produced, even with the full utilization of science, without hard work. The ultimate consideration, he said, is moral control, of which the simplest expression is live and let live. He wondered whether it came within the province of science to obtain that indispensable moral control.

Other speakers described developments in the British Commonwealth in the attempt to supply the world with more food.

Sir David Rivett said that Australia would need more first-class scientists. Geneticists are needed to develop from British cattle breeds that are already established in Australia, strains adapted to local conditions. The fertility of rams is affected by high temperatures, and knowledge of climatic influences on the fertility of rams and ewes is needed to raise the present low lambing percentage. Speaking of the possibility of more efficient use of present resources, he told of how, in Australia, skimmed milk is used mainly as pig food. But research has revealed that in that waste there are more first-class animal proteins than in the whole of the beef and mutton production of the Commonwealth.

A. C. Hardy rather startled many scientists when, in his section presidential address "Zoology Outside The Laboratory," he expressed a belief in telepathy. He said:

> It is perhaps unorthodox for a zoologist to introduce such a topic, but I do so for a reason. If telepathy has been established, as I believe it has, then such a revolutionary discovery should make us keep our minds open to the possibility that there may be so much more in living things and their evolution than our science has hitherto led us to expect.
>
> Such an idea as I am about to suggest is no doubt highly improbable and would perhaps be better kept locked in a bottom drawer; I mention it, however, merely as a reminder that perhaps our ideas of evolution may be altered if something akin to telepathy—unconscious, no doubt—was found to be a factor molding the pattern of behavior among members of a species. If there was such a nonconscious group behavior plan, distributed between, and linking, the individuals of the race, we might find ourselves coming back to something like those ideas of subconscious racial memory of Samuel Butler, but on a group rather than on an individual basis.
>
> It would remove many of the fatal difficulties of his hypothesis. Samuel Butler's ideas were, of course, the logical development of Lamarck's, but thought of independently.

If there was such a group habit and behavior pattern it might operate through organic selection to modify the course of evolution; working through selection acting on the gene-complex. If this flight of fancy ever proved to be a fact, it would be a wedding of the ideas of Darwin and Mendel on the one hand, and Samuel Butler and Lamarck on the other.

Professor Hardy made a plea for more ecological research. He defined ecology as "the conversion of natural history into science," which involved more than the expressing of the interrelationship of organisms with their environment, living and inanimate, in numerical terms. The aim of ecology is to discover more of the laws operating in the world of living things. He remarked on the fact that ecological knowledge of marine life is much more advanced than that of man's ordinary terrestrial surroundings.

Sir Alexander Gray, in his presidential address "Economics: Yesterday and Tomorrow," said that the problem of government is essentially one of expediency; above all, it is concerned with the urgent question of how to keep going for the next six months. The enunciation of a flawless theory of wages, if such could be formulated, would never still the passions which had given rise to a strike. Accordingly, he believes the economic adviser should at times be able to forget that he is an economist, and indeed to realize that there might be occasions when he ought to forget his economics. He is certain that a structure of economic theory that is not based on sound psychology is a house without foundation, therefore the economist must be a psychologist, of a sort.

There is no room here to do more than mention some of the other interesting papers that were read.

Kenneth Oakley, of the Natural History Museum in London, read a paper to the anthropological section on his fluorine test. Fluorine is a gas which, in the form of fluorides, occurs as a trace in most ground water. When fluorine ions reach bone material, they are locked into the ultramicroscopic mesh of the calcium phosphate crystals. Once they thus enter they are not released, and the fluorine content of the bone increases with time. This fact provides rather a neat means of distinguishing fossilized bones of different ages occurring at a particular place, though it does not make it possible to date an individual bone in isolation.

In the physics section, some papers were read on recent techniques applied to astronomical problems.

J. S. Hey, of the Army Operational Research Group, dealt with investigations of solar radio noise. This is emitted in two forms. First there are fairly sharply beamed emissions from sunspots, a maximum being obtained when the sunspot is near the central meridian on the sun's disk. Next there are very sudden bursts of emission from solar flares, which are tongues of very hot gas moving at immense speed from the solar surface near the sunspots. This type of emission is characterized by its suddenness, and it does not appear to be beamed. There seems to be a greater chance of radio emission with flares occurring on the east side of the sun's disk than with flares in any other position. Intense ionization of the lower part of the ionosphere is simultaneous with the flare and the radio emission. It seems that this intense ionization is caused by ultraviolet light from the flare, and the result is a complete black-out of long distance radio communication on the earth.

F. G. Smith, of Cambridge, described work on radio techniques applied to the analysis of radio noise coming from the rest of the galaxy. The first problem is to determine whether the noise comes from a diffuse interstellar gas or from point sources such as the known stars. From experimental evidence at Cambridge it appears that there are two major sources and 23 smaller ones, and with certain assumptions the diameter of the source seemed to be less than ten light seconds, i.e., of the order of size of an average visual star. It appears that the noise is due to electrons having a random motion of at least 10^{10} electron volts. The great energy suggests that the origin of cosmic rays is the same as that of the radio noise investigated.

A. C. B. Lovell, of Manchester, described new developments in meteor astronomy. He said electron trails formed by the burning away of a meteor make excellent radar targets and can thus be detected on a cathode-ray screen. Difficulties occur because of the immense speed of the meteors, in the neighborhood of 100,000 miles an hour, thus producing radar echoes of extremely minute duration. As the central problem of meteor astronomy is to discover where the meteors come from, it is very important to determine the meteor speed very accurately, for a difference of less than 1 percent in the velocity means the difference between a meteor belonging to the solar system, i.e., moving in an orbit around the sun, and one from interstellar space.

W. C. Hodgson and K. M. Rae described two types of apparatus for submarine investigation. The continuously recording echo-sounder gives the depths at which fish are swimming and allows the nets to be adjusted accordingly. It also allows the extent of a shoal to be calculated and therefore the likely catch. Herrings, sprats, cod, and mackerel can all be identified by the characteristic trace they give on the paper record. The other apparatus is a recorder which, towed behind a ship, gives a continuous record of plankton (the small animal life on which fish feed). Much time, money, and effort could be saved by this technique when fishing research comes to be conducted in such large areas as the Pacific. It would give a broad basis on which to plan more detailed research cruises.

The impact of science on society was implicit in all papers read, and Sir John Russell, in his presidential address, raised some controversial points about the powers of science. He said:

> It can do much to overcome material difficulties and, better still, to satisfy man's thirst for knowledge of the universe in which he lives, and it can insist continuously on our high duty to seek out the truth fearlessly and honestly, and having found what we believe to be the truth, to proclaim it—but in all humility and recognizing that we may be wrong. Apart from that, science can give little guidance in those great moral and spiritual problems which lie at the root of our most serious troubles today. It opens up many possible ways of life but gives no help in choosing which to follow, it deals with the facts of existence but not with the values of existence. It offers us great possessions but, as the old aristocracy knew, great possessions imply great personal responsibilities. Democracies still have this to learn. That is one of our greatest problems today.
>
> Science can help us best if we have a sustaining faith, a high purpose in life and unflinching courage to pursue it.

Sir Alfred Egerton summed up the general feeling when he said:

> Looking back to the turn of the century and remembering the stage of chemical science at that time, then seeing in my mind's eye the integrated achievements of chemists since those days, I cannot but believe in a bright future: "That which they have done is but an earnest of the things they shall do."

Next year's meeting is to be held in Birmingham, and the new president of the British Association for the Advancement of Science is Sir Harold Hartley. The 1951 meeting is to be held in Edinburgh, under the patronage of the Duke of Edinburgh.

TECHNICAL PAPERS

A Reversible Photochemical Alteration of Uracil and Uridine[1]

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Various lines of evidence (*1, 3, 4*) have suggested that the primary effect of lethal and mutagenic doses of ultraviolet radiations upon living cells may be partially reversible, or at least compensated within the cell. In connection with a general study of the photochemistry of nucleic acid derivatives, we have discovered that, under certain conditions, the initial photodecomposition product of the pyrimidine, uracil, and the corresponding product of the ribose nucleotide, uridine, may spontaneously revert to the initial substances, uracil and uridine, respectively.

A distinction must be made between the effects of radiation in the longer wave pyrimidine absorption region, 2300–2800 A, and the effects of short wave radiations of wavelength less than 2300 A. The former radiation gives rise to the partially reversible effect, whereas the latter produces—with a much higher quantum efficiency—an irreversible decomposition.

In our experiments we have employed as a radiation source a low pressure mercury discharge tube, wound in the form of a spiral, obtained from the Hanovia Chemical and Manufacturing Company. The principal radiation from this tube is the 2537-A mercury line, but photochemically significant quantities of 1849-A, 1942-A, and 2224-A radiation are emitted. We have filtered these latter out with a 1-cm path of absolute ethyl alcohol.

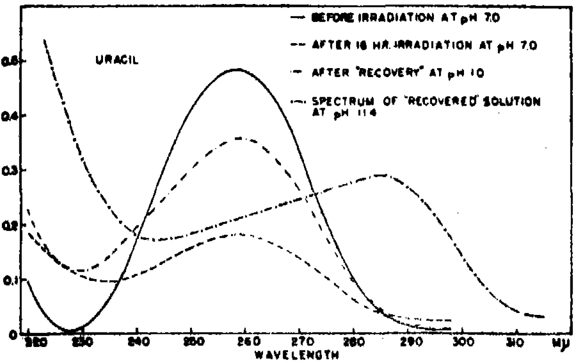

FIG. 1.

The solutions have been irradiated directly in the silica cells of the Beckman DU Spectrophotometer. Under these conditions, it is possible to destroy 63% of the absorption of a uracil solution (6.2 μg/ml in M/100 PO_4 buffer, pH 7.0) at the uracil maximum, 2590 A, in 16 hr of irradiation (Fig. 1). If now the pH of the irradiated uracil solution is changed to 1.0 (by addition of 1 ml 1 M HCl to 3 ml of irradiated solution), the absorption at 2590 A is then found to rise exponentially, following first-order kinetics, with a rate constant of 14 min at room temperature. As shown in Fig. 1, 74% of the

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[1] This study was supported by the American Cancer Society, acting through the Committee on Growth of the National Research Council.

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initial absorption can be recovered. That the substance responsible for the recovered absorption is uracil is indicated by the absorption spectrum and by the characteristic shift in absorption (*2*) upon making the solution of the recovered material alkaline to pH 11.4.

Some increase in absorption takes place if the irradiated solution is allowed to stand at pH 7.0, but the rate of increase is extremely slow at room temperature. This rate may be accelerated by increase of temperature; immersion of the irradiated solution into boiling water for 15 min can bring an increase in absorption comparable to that produced by addition of acid. Recovery in acid solution, however, has given more reproducible results.

Irradiation of uridine has led to qualitatively similar results. Uridine appears to be some 16 times as labile to ultraviolet irradiation as uracil, when compared at pH 7.

Under these conditions of irradiation, thymine, cytosine, adenine, and guanine, and adenylic and guanylic acid are not decomposed. However, preliminary experiments have given evidence of a similar reversible phenomenon with cytidylic acid.

More complete details of this work will be published elsewhere.

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A Polarographic Determination of Digitoxin[1]

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In conjunction with a polarographic investigation of a variety of organic compounds of pharmaceutical interest, a study of the polarographic properties of digitoxin was instituted. Fieser (*1*) reported that the cardiac glycosides gave polarographic half-wave potentials in the region between −1.9 and −2.0 volts. The present investigation confirms Fieser's work and elaborates on the qualitative and quantitative polarographic properties of digitoxin. The results of this study show that digitoxin may be determined in concentrations as low as 0.1 μg in 50% alcohol solution and may also be extracted by means of suitable solvents from complex mixtures and determined in similar low concentrations.

The method used to carry out these investigations was as follows: A stock solution of the pure drug[3] was prepared by dissolving 25 mg of digitoxin in 12.5 ml of absolute alcohol and diluting to 25 ml with distilled water. Varying amounts of the stock solution were added to 0.5 ml of 0.2 *N* tetraethyl ammonium hydroxide in a Heyrovsky reaction vessel and diluted to 5 ml total volume with 50% alcohol solution in order to study the half-wave potential and height of break at different concentrations. For extremely low concentrations, a stock solution of lower concentration was prepared and diluted in a similar manner. Nitrogen was bubbled through the prepared solutions for a period of 15–20 min and the polarogram recorded. This process was repeated until a satisfactory curve of height versus concentration had been determined for the concentrations under investigation and the average half-wave potential was calculated.

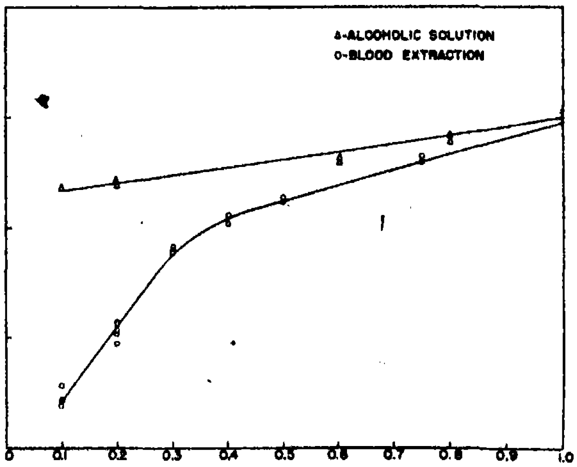

FIG. 1. Height versus concentration curves for digitoxin between 0.1 and 1.0 μg. Upper curve (△), alcoholic solution; lower curve (◯), extraction from blood. Abscissas, concentration of digitoxin in μg; ordinates, height in in. (1 in. = 0.508 μa).

The study of digitoxin in blood was carried out by a combination of extraction and polarographic work. The most satisfactory extraction solvent was found to be petroleum ether. The procedure followed for the investigation in this portion of the experiments was as follows: Varying amounts of stock solution were added to 10 ml of mixed blood, and 2.5 times the total volume of petroleum ether used for extraction. The combined mixture and extraction solvent solution was placed in a separatory funnel and shaken. After thorough settling, the residual blood was drawn off. The remaining solution was shaken and allowed to settle until no blood residue appeared after shaking. The petroleum ether fraction was placed in an evaporating dish and evaporated to dryness. This residue was dissolved in 2.5 ml of absolute alcohol and decanted so that no alcohol-insoluble components would be in the final solution. The alcohol solution of the residue was diluted to 5 ml with distilled water and 2.5 ml of this solution was placed in a reaction vessel with 2.0 ml of 50% alcohol solution

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[1] This investigation was supported in part by research grants from the Division of Research Grants and Fellowships of The National Institutes of Health, U. S. Public Health Service, and The American Cancer Society.

[2] The author wishes to thank Dr. C. L. Gemmill for suggesting this problem and for his guidance in this study.

[3] Grateful acknowledgment is made to Dr. K. K. Chen, Eli Lilly and Company, Indianapolis, Indiana, for the purified digitoxin used in this study.

and 0.5 ml of 0.2 *N* tetraethyl ammonium hydroxide. Nitrogen was bubbled through the solution for 15–20 min and the polarogram recorded. In this investigation, as in the study of the alcoholic solutions of digitoxin, multiple runs were made until a satisfactory height-versus-concentration curve was obtained and the average half-wave potential was calculated.

The results of these experiments show that digitoxin may be determined in concentrations as low as 0.1 μg in both alcoholic solutions and in blood. Multiple determinations run on concentrations between 0.1 and 0.4 μg of digitoxin in blood show the error in this method to be ± 0.02 μg. Fig. 1 shows the height of polarographic break for various concentrations of digitoxin in alcoholic solutions and in blood extracts. This figure also shows the relationship between height of break for alcoholic and blood determinations. It may be seen that in concentrations down to approximately 0.6 μg the two curves coincide reasonably well; however, below this concentration the curve of digitoxin extracted from blood drops sharply and approaches zero. This drop from the alcoholic curve may be due to the distribution of digitoxin between the extraction solvent and blood at these low concentrations. The use of the arbitrary curve, although it varies from the curve of digitoxin in alcoholic solution, is based upon the results of multiple determinations which show a low error (± 0.02 μg) in the concentrations where the deviation is greatest. The average half-wave potentials were found to be − 1.965 in alcoholic solution and − 1.958 when extracted from blood.

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Effect of Sulfadiazine on Survival of the Mammalian Embryo[1]

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It has been shown by Detwiler, Copenhaver, and Robinson (*2*) that sulfadiazine in solutions of 1% or higher is frequently toxic to *Amblystoma* embryos in early developmental stages. More recently, Copenhaver and Detwiler (*1*) showed that 2% concentration of sulfadiazine caused a failure to survive to the stage of yolk resorption. They also observed abnormalities of various structures in the organism. S. Y. P'an (*4*) has shown that sulfamethiazine when administered to normal male rats produces gross and microscopic atrophic changes in the testes, seminal vesicles, and anterior prostate. Recently, Figge *et al.* (*5*) reported on the influence of sulfonamide drugs on cancer susceptibility, and reproduction in mice. He has observed that there is a decrease in reproduction in mice maintained on constant medication with certain sulfonamides. Two of the authors (Yntema and Hammond) have found that sulfadiazine is more lethal to chick embryos during the first half of the second day of incubation than it is subsequently. The drug appeared to interfere with the development of the vascular system. These studies suggested that sulfonamide administration might interfere with early development of the mammalian embryo.

TABLE 1

Expt. No.	Treatment*	Given on days	No. of mice	No. of deliveries (full term)	Percentage deliveries	χ^2	*P*
1	Untreated		56	27	48.2	7.64	0.0057
	Sulfadiazine†	5–15	56	13	23.2		
2	Untreated (isocaloric)		49	16	32.7	1.6	0.109
	Sulfadiazine	5–15	47	10	21.3		
3	Sulfadiazine	8–12	79	33	41.8		
	"	6–10	79	11	13.9	15.24	0.0001
	"	10–14	79	29	36.7	10.84	0.001
4	Sulfadiazine	6	109	15	13.8	23.18‡	
	"	7	104	15	14.4	22.39‡	

* Administered only in the diet in Experiments 1–3. In Experiment 4, one injection of 12 mg sulfadiazine sodium was given intraperitoneally, in addition to administration of sulfadiazine in the diet for the 6th or 7th day.

† *Eight-tenths percent of diet.*

‡ Compared with untreated controls in Experiment 1.

To investigate this, we selected white mice as our experimental animal and used sulfadiazine as a representative of the sulfa group of drugs. A diet of Purina dog chow containing 0.8% by weight of sulfadiazine was employed. The breeding cages contained four females and one male. Females were examined each morning. Those having vaginal plugs were removed, numbered, and placed in individual cages. Only the females showing vaginal plugs were selected for the investigation.

Experiment 1 (Table 1) represents the results obtained when such animals, beginning on the 5th day following conception, were fed sulfadiazine in the diet for a period of 10 days. The percentage of deliveries in this treated group was 23.2%, in contrast with 48.2% in the untreated control group. When untreated animals were fed isocalorically there was a reduction of deliveries, as indicated by the results of Experiment 2. However, this reduction did not reach the level noted in the sulfadiazine-treated animals.

It was of interest to localize more accurately the time at which the sulfonamide was effective. Experiment 3 indicates the results. Here it was shown that the period from the 6th to the 8th day was the one at which the sulfonamide was effective.

To localize further the most effective interval, Experiment 4 was conducted, in which animals were given sulfonamide for 1 day only. Here sulfadiazine sodium was

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[1] This investigation was supported by a research grant from the Hendricks Fund at Syracuse University.

administered intraperitoneally, so that initial high sulfadiazine levels could be obtained. Following the intraperitoneal injection, the mice were placed on the sulfadiazine diet for 24 hr. Similar results were obtained whether sulfonamide was administered only on the 6th or only on the 7th day following appearance of the vaginal plug. No data have been obtained concerning the period from the 1st to 6th day.

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Enzymatic Reduction of 2,4-Diketo Acids Catalyzed by Dihydrodiphosphopyridine Nucleotide

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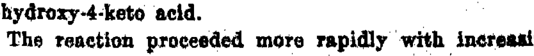
The reduction of pyruvic acid to lactic acid, catalyzed by dihydrodiphosphopyridine nucleotide ($DPNH_2$) in muscle extracts is well known. An apparently analogous reaction in which 2,4-diketo acids are reduced has been observed. When a series of homologous 2,4-diketo acids was incubated with 90% pure $DPNH_2$[1] and an aqueous extract of an acetone powder of rabbit muscle at pH 7.2, the characteristic absorption band of these compounds at 2900 A and the band due to $DPNH_2$ at 3400 A disappeared progressively. Equimolar amounts of coenzyme and diketo acid were utilized, suggesting the reduction of one keto group. In a typical experiment using a system containing 5×10^{-7} moles each of 2,4-diketovalerate and $DPNH_2$, 10^{-4} moles of phosphate buffer at pH 7.2, and 80 γ of protein nitrogen per 3 ml, 2.48×10^{-7} and 2.44×10^{-7} moles of $DPNH_2$ and diketo acid, respectively, disappeared after 12 min of incubation at 25° C. Neither $DPNH_2$ nor substrate disappeared when one of these was omitted from the system or in the absence of enzyme. No lactate was formed as determined by the method of Barker and Summerson (*1*), ruling out prior hydrolysis of the diketo acid to pyruvic acid (*3*). The facts are compatible with the equation,



$$\underset{\substack{\| \\ O}}{RC}\,CH_2\underset{\substack{\| \\ O}}{C}OOOH + DPNH_2 \rightarrow \underset{\substack{\| \\ O}}{RC}\,CH_2\underset{\substack{| \\ OH}}{C}HCOOH + DPN$$

whereby the product is considered tentatively to be the 2-hydroxy-4-keto acid.

The reaction proceeded more rapidly with increasing concentrations of substrate and was conveniently followed spectrophotometrically by measuring the rate of decrease of the $DPNH_2$ band at 3400 A. All of the normal 2,4-diketo acids from valeric to undecylic were reduced in the system, as shown in Table 1. Under the same experimental conditions, neither 4-keto valeric acid nor 3,5-diketohexanoic acid was reduced. The nature of the enzyme involved and its possible relationship to lactic dehydrogenase is under investigation.

TABLE 1

Enzymatic Reduction of 2,4-Diketo Acids*

2,4-Diketo acid	Disappearance of $DPNH_2$
	(Moles × 10^{-7} per min)
n-Valeric	1.83
n-Hexanoic	1.74
n-Heptanoic	1.45
n-Octanoic	1.48
n-Nonanoic	1.36
n-Capric	1.33
n-Undecylic	1.45

* Composition of system in moles per 3 ml was 5×10^{-7} $DPNH_2$, 9×10^{-6} diketo acid, 1×10^{-4} phosphate buffer (pH 7.2); and 0.1 ml enzyme preparation (100 γ protein nitrogen) per 3 ml; 25° C.

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A Convenient Quick Method of Obtaining Vitamin B_{12} Concentrate[1]

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The nonprotein filtrate of liver homogenate (proteins coagulated by boiling at pH 5.0) chromatographed on starch columns by the method of Moore and Stein (*1*) gave a reddish brown fraction in the first portions of the effluent.

The behavior and color of this fraction suggested a possible relation to B_{12}. This was tested as follows: 0.5 ml of liver injection, USP (Lederle Solution Extract, from beef liver, 15 u per ml) was dried by blowing air across it at room temperature. To the residue 0.1 ml 1*N* HCl was added, and then 0.5 ml of a mixture consisting of 0.1 *N* HCl, *n*-propanol, and *n*-butanol in the proportions 1: 2: 1. The solution was chromatographed on 25 g starch in a 10-mm × 300-mm column with the 1: 2: 1 mixture as solvent.

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[1] DPN was purified by countercurrent distribution as described by Hogeboom and Barry (*2*). Cruder preparations tended to interfere with measurements made at 2900 A.
m = calibration factor for adrenalin

[1] This work is part of that done under a joint contract with the Office of Naval Research, United States Navy Department, and the United States Atomic Energy Commission.

The first 4.2 ml of the effluent was colorless. The next 1.8 ml, fraction 1, was slightly colored; the next 1.8 ml, fraction 2, was deep reddish brown; a third 1.8 ml, fraction 3, was slightly colored. No more of the effluent, up to a total volume of 22.2 ml, was colored.

The three colored fractions were submited to Karl Folkers, of Merck and Company, for analysis. He reported the following: fraction 1, 80 microbiological units per mg; fraction 2, 2000 units per mg; fraction 3, 240 units per mg.

As the color accompanies the activity, it is easy to know what portion of the effluent to collect. The method offers a way of obtaining B_{12} active material from commercially available sources, which already contain the activity in a conveniently small volume.

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Fat Absorption and Atherosclerosis[1]

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In our work on the effect of age on fat absorption (*1*) we have observed a phenomenon which may be fundamental in the pathogenesis of atherosclerosis.

Using a modification of Frazer's chylomicron dark field technique (*1*, *2*), we have studied the absorption of fat in thirty young and in thirty old subjects with average ages of 18 and 76 years respectively. The fasting subjects were given a standard fat meal of ½ g of oleomargarine/kg of body weight on 2 oz of white toast together with a cup of tea. Samples of finger blood were drawn before and after the meal at regular intervals as indicated in Fig. 1. The number of chylomicrons in the serum of each specimen was determined and chylomicrographs were constructed.

As shown in Fig. 1, the chylomicron counts of young subjects reached a peak at 2½–3 hr, and returned to fasting levels by the end of the 5th hr. The counts of the old group on the other hand did not reach their peak until 8–12 hr, and they did not return to fasting levels until 24 hr had elapsed. In addition, the total number of chylomicrons was found to be consistently and considerably higher in the old than in the young group.

Previous work by Gage and Fish (*4*), and Frazer (*2*) has established that the chylomicron curve serves as an index of postabsorptive lipemia. From our results it is obvious that a definite delay in the rate of absorption and a definite increase in the total absorption of corpuscular fat exist in aged individuals as compared with a group of young subjects.

The observations of Hueper (*6*, *7*) and of Moreton (*9*, *10*) seem to indicate that the alimentary hyperlipemia and its accompanying high concentrations of chylomicrons in the peripheral blood, occurring in normal individuals, are indistinguishable from the sustained hyperlipemia and hyperchylomicronemia of pathological and experimental origin which have been found to be characteristic of the known causative conditions of atherosclerosis.

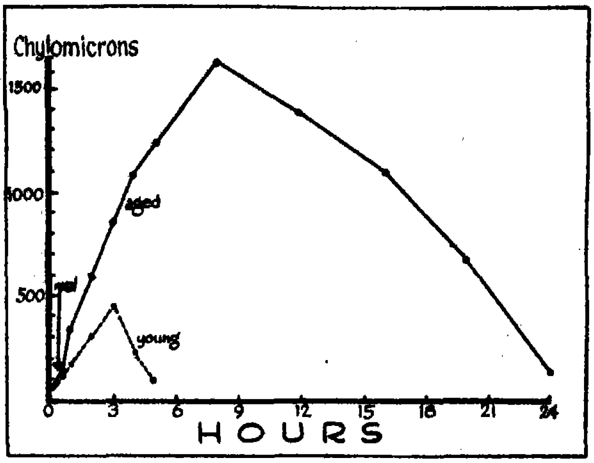

FIG. 1.

Hueper (*6*, *7*) and Moreton (*9*, *10*) state that macromolecular substances can be deposited and can damage the internal layers of arteries. Chylomicrons are macromolecular bodies containing largely neutral fat and some cholesterol (*2*, *3*, *9*, *10*). The neutral fat, according to Moreton (*9*, *10*), disappears rapidly from the intima and subintima, while the cholesterol remains and accumulates gradually, attracting macrophages, giving rise to foam cells, and ending in atherosclerosis.

The question is still controversial, whether endogenous or alimentary cholesterol produces atherosclerosis in man. This cholesterol is in true solution and it is possible that chylomicrons, which are macromolecular aggregates, are the source of irritation and degeneration of arterial walls, rather than cholesterol, fats, or other lipids in the dissolved state (*6*, *7*, *9*, *10*). In the chicken, endogenous cholesterol seems to play a large role in the genesis of arteriosclerosis (*5*).

Increased chylomicronemia following fat-containing food occurs at every age. However, it lasts only a relatively short time and it is only of moderate intensity in young persons. With increasing age, and particularly above 50 years of age, chylomicronemia is of greater intensity and it is practically permanent. If the chylomicrons play a role in atherosclerosis, the fundamental physiological basis of the mechanism of the disease may lie in this fact.

Another significant observation made was that oral ad-

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[1] Aided by a grant from the A. B. Kuppenheimer Fund. The department is in part supported by the Michael Reese Research Foundation. The help of Dr. H. Sorter, Medical Director, of Mr. B. Grossman, Director, and of the staff of the Home for Aged Jews is acknowledged gratefully. We are obliged to Dr. B. M. Kagan and the staff of Sarah Morris Hospital for their cooperation.

ministration of lipase[2] or of a detergent (Tween 80)[3] with the fat meal reduced the hyperchylomicronemia of older persons to practically the level of the younger age group. The chylomicron count in young persons following a fat meal was not influenced materially by the administration of lipase with the fat meal.

We have found earlier (*11*) that pancreatic lipase secretion and blood lipase levels are significantly lower in older persons than in young ones. The effect of lipase or of a detergent in reducing the hyperchylomicronemia in old subjects to levels of young subjects seems to support the assumption that the mechanisms of fat digestion or of fat absorption, probably both, change with aging. It is not probable that hyperchylomicronemia is due to delayed disposition of circulating fat, because intravenous injection of equal volumes of hyperlipemic plasma into young and old subjects yielded similar chylomicron curves (*1*). It is premature to speculate whether administration of lipase or of detergent to normal persons may prohibit the development of atherosclerosis, or whether the progression of the disease can be interrupted by the administration of lipase or of detergent. Animal experiments may answer this question.

In persons over 50 years of age ingestion of a small amount of oleomargarine was followed by a practically 24 hr increase in the chylomicron count in the serum. In younger persons the chylomicron curve returned to fasting levels within 5 hr. Since all people eat some fat at least once a day, increased numbers of fat particles circulate in the blood of older persons practically permanently. If it is true that particulate fat, circulating in the blood, leads to atherosclerosis, the condition leading to that degenerative disease has been found.

Administration of lipase or of detergent with the fat meal reduced the chylomicron counts and the duration of increased counts of old subjects to levels of young subjects.

Work on animals will show whether atherosclerosis can be influenced by drugs affecting digestion and absorption of fat.

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[2] Kindly supplied by Dr. D. Klein, Wilson Company, in the form of concentrated pancreatin.

[3] Kindly supplied by Dr. G. R. Hazel, Abbott Laboratories.

A Vibrating Tissue Slicer[1]

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Some recent studies (*5*) of the metabolism of brain cortex slices required six or eight parallel experiments on the same brain. Neither the freehand method (*4*), nor the microtome method (*3*) yields sufficient material from brains of guinea pigs or rabbits. We have found that a vibrating blade with freehand manipulation can provide 500 mg of cortex slices from a full-grown guinea pig brain. The source of vibration is a mechanical wood carving tool (Burgess Vibro-Tool), which develops a push-pull vibration at a frequency of 120 per sec. There is only slight lateral vibration. In the chuck, we fastened a split metal adapter tightened by a wing nut, which can hold 2-in. pieces of Stadie blades or single-edge razor blades.

TABLE 1

	Hand cut		Cutter	
	Wet weight in mg	Q_{O_2}	Wet weight in mg	Q_{O_2}
Mouse liver	122	5.77	78	6.08
	94	6.28	82	5.58
	112	5.79	92	6.06
Average		5.95		5.92
Guinea pig brain cortex	52	9.18	57	10.20
	72	9.72	71	9.29
	58	10.10	63	9.56
Average		9.67		9.68

The platform upon which the cerebral hemisphere is placed is made by filling a 50-mm crystallizing basin with ice and water to overflowing, sliding the bottom of a larger basin over it, and inverting the basins. The ice floats to the top, causing the platform to be chilled. The cerebral hemisphere, with meninges and blood vessels removed, is placed on a small square of moistened filter paper on this platform.

The cutter, with the edge facing the operator, is grasped firmly in both hands, one arm resting on the table edge for added stability. The vibrating blade is drawn slowly through the tissue, toward the operator, with a wrist motion. The slice lies flat on the blade, and the plane of the cut can be varied for thickness of slice and for contour of the tissue without the necessity of guiding and sawing simultaneously, which is inherent in the freehand method. The slice can be picked off the blade with a fine forceps or can be removed by dipping the vibrating blade into a small beaker of chilled Ringer's solution. The blade must be moistened slightly if the slicing is to be done in the open, but need not be moistened in the humid box of Sperry (*2*) or the moist cold box of Fuhrman and Field (*1*).

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[1] This work has been supported in part by the Office of Naval Research and the International Minerals and Chemical Corporation.

There is no apparent change in the tissues induced by the low frequency vibration of the blade, as measured by the 1-hr oxygen uptake of comparative portions of the same organ sliced by hand (*4*) and by the vibrating cutter, as shown in Table 1. The medium used was Kreb's Phosphate Ringer's, pH 7.4, at 37° C, with air atmosphere. The brain medium also contained .011 molar glucose.

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The Chemical Nature of a Factor in Hog Stomach Extracts that Reduces the Creatinuria of Muscular Dystrophy[1]

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A labile factor, assayed by its effect on lowering the creatinuria of a patient with progressive muscular dystrophy, has been found to concentrate in the fat fraction (7) of hog gastric mucin[2] and of hog stomach linings[3]. But attempts at further fractionation of this concentrate by countercurrent distribution between absolute methanol and isooctane led to a rapid loss of biological activity. The crude fat fraction contained up to 1%[4] of a substance which reduced ferric chloride in a modified Emmerie and Engel (*1*) assay. This reducing property proved to be a measure of biological activity, since loss in biological activity was associated with a decrease in amount of reducing substance. None of the four naturally occurring tocopherols, which also reduce ferric chloride in the assay of Emmerie and Engel, could have accounted for the biological activity, since they were without effect on the creatinuria of this patient at doses 25 times the active dose of reducing substance from stomach extracts. Alpha (*6*), beta, and gamma tocopherols (*4*), however, do abolish the creatinuria of the muscular dystrophy of experimental vitamin E deficiency.

The fat fraction of hog gastric mucin which lowered creatinuria at a dosage of 100 mg was allowed to lose activity by standing at room temperature for 3 months. The amount of reducing substance fell from 0.77% to 0.07% and biological activity was completely lost. This suggested a destruction by autoxidation which leads, in the case of tocopherols in the presence of fats, to the formation of tocopheryl-*p*-quinones (*6*). The tocopheryl-*p*-quinones, in turn, can be reduced to the corresponding tocopheryl-*p*-hydroquinones and cyclized in the presence of mineral acid to regenerate the original tocopherols (*5*). The following experiments, which were designed to regenerate any tocopherols in the inactivated fat fraction that had undergone autoxidation and tocopheryl-*p*-quinone formation, led to the finding that an intermediate in the reaction, a simple reduction product, possessed chemical and biological properties similar to the factor in the fat fraction of hog gastric mucin. A 100-mg portion of inactivated fat fraction was refluxed for 2 hr in an isooctane-ethanol mixture containing 5.0 g stannous chloride and 5.0 ml concentrated HCl. After addition of water and recovery of the isooctane layer, the amount of reducing substance was found to have increased to 1.08% and remained stable at this value. A 225-mg dose of this material containing 2.43 mg of reducing substance had no effect on creatinuria. A control experiment with pure alpha tocopheryl-*p*-quinone under the same conditions showed complete conversion to alpha tocopherol ($E_{1\,\mathrm{cm}}^{1\%}$ [298 mμ] in isooctane = 70; $E_{1\,\mathrm{cm}}^{1\%}$ [520 mμ] in the Emmerie and Engel assay = 370). Another 100-mg portion of inactivated fat fraction of gastric mucin was refluxed for 30 min in the same solvent with 0.7 g stannous chloride and 0.5 ml concentrated HCl, and the isooctane layer was recovered as described. The reducing substance had increased to 0.73% but fell to 0.30% on the second day, 0.27% on the third day, and to 0.21% by the end of a week. A 225-mg dose of this material, containing 1.03 mg of reducing substance, was biologically active. The control with pure alpha tocopheryl-*p*-quinone under these conditions showed the formation of alpha tocopheryl-*p*-hydroquinone by the appearance of an absorption maximum at 290 mμ which disappeared in the course of 18 hr, as the spectrum of alpha tocopheryl-*p*-quinone reappeared with a double maximum between 260 and 270 mμ. This rapid autoxidation is characteristic of alpha tocopheryl-*p*-hydroquinone, first described by John (*5*). The creatinuria-lowering activity of the fraction of gastric mucin treated in this way was fully duplicated by 1.0 mg of pure synthetic alpha tocopheryl-*p*-hydroquinone.

Alpha tocopheryl-*p*-hydroquinone was prepared as needed from the more stable alpha tocopheryl-*p*-quinone by catalytic hydrogenation in ethanol or propylene glycol with palladium on calcium carbonate. The $E_{1\,\mathrm{cm}}^{1\%}$ (290 mμ) in isooctane was 88 immediately after hydrogenation, a value somewhat higher than that reported by John (*5*). The $E_{1\,\mathrm{cm}}^{1\%}$ (520 mμ) in the Emmerie and Engel assay was

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[1] This work has been aided by the Armour Fund for Research in Muscular Disease and by a grant from the Nutrition Foundation.

[2] Frederick Stearns and Company. Prepared by alcoholic precipitation of an acid digestion of hog stomach linings.

[3] A low temperature concentrate of an acetone extract of hog stomach linings was kindly furnished by the Armour Research Laboratories.

[4] Calculated from a standard curve for alpha tocopherol.

390. Alpha tocopheryl-*p*-quinone was prepared by the oxidation of natural or synthetic alpha tocopherol with ferric chloride (*2*) and purified by the method of Tishler and Wendler (*8*) to an $E^{1\%}_{1\,\mathrm{cm}}$ (268 mμ) in isooctane of 450.

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Taste Blindness to Phenyl-Thio-Carbamide as a Function of Saliva

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In 1931, A. L. Fox (*6*, *7*) of the E. I. du Pont de Nemours Company discovered that approximately 60% of the Causasian population are able to taste phenyl-thio-carbamide (P. T. C.) as bitter, while the remaining 40% find it to be as tasteless as chalk. The literature of the physiological, genetic, environmental, and ethnological characteristics of this phenomenon has been reviewed by Cohen and Ogdon (*3*).

Blakeslee (*1*), Fox (*4*), Mee (*5*), and Blakeslee and Salmon (*2*) have all suggested that it may be the saliva which is the determiner of the ability to taste or not, and not the "taste apparatus" itself. Fox specifically suggested the possibility that nontasters have in their saliva a product, possibly a protein or a colloid, which precipitates the P. T. C. as a very insoluble substance which does not give rise to a taste sensation.

The question as to the effect of the saliva may be settled by allowing tasters and nontasters to taste P. T. C. using another taster's or nontaster's saliva. A population of 35 American college students was first tested with P. T. C. crystals and each individual classified as a taster or a nontaster. Then each person (whether taster or nontaster) was tested with each of the following tests: 1) D test, using a saturated solution of P. T. C. in tap water on a dry (dried by air from an atomizer) tongue; 2) G test, using a saturated solution of nontaster's saliva on a dry tongue; 3) P test, using a saturated solution of P. T. C. in taster's saliva on a dry tongue. The taster's and nontaster's saliva was obtained from other individuals selected purely at random. No saliva from any person was used for more than one test on more than one subject. The results are given in Table 1.

As a control, 19 individuals were tested with the R test, using saturated solutions of P. T. C. in their own saliva, which had been allowed to remain exposed to air about 5–10 min, on a dry tongue. The results are given in Table 2.

TABLE 1

Sensations of 35 Observers to P. T. C. Dissolved in Water, and Taster's and Nontaster's Saliva on a Dry Tongue

	D Test	G Test	P Test
26 Tasters*	T = 0	T = 0	T = 0
	NT = 26	NT = 26†	NT = 26
7 Nontasters	T = 0	T = 0	T = 0
	NT = 7	NT = 7	NT = 7‡

T = tastes bitter.
NT = no taste.

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* Four subjects reported only weak taste of bitter.

† One subject reported slight sensation, but was unable to describe it.

‡ One subject reported a "warm" sensation.

These data seem to indicate that an individual will taste P. T. C. as bitter when the following two necessary conditions are met: 1) He must have the correct "taste apparatus," and 2) he must have his own saliva (or, presumably, its chemical equivalent). A nontaster cannot taste in any event, even when he uses the saliva of another taster. A taster cannot taste under any circumstances, except when he uses his *own* saliva; he cannot taste if he uses the saliva of another taster or nontaster. He can taste if he uses his own saliva, even though the saliva is placed on his tongue in exactly the same manner as the saliva from another individual. No subject can taste P. T. C. when the crystals are dissolved in water and no saliva is used at all.

TABLE 2

Sensations of 19 Observers to P. T. C. Dissolved in Their own Saliva on a Dry Tongue

	R Test
17 Tasters	T = 16
	NT = 1*
2 Nontasters	T = 0
	NT = 2

* This subject had previously reported a weak bitter taste to the crystals.

Salivas are probably as different as fingerprints. Blakeslee and Salmon (*2*) have also found that saliva is important to taste P. T. C. Our finding that it must be the individual's own saliva may be brought about by the fact that the "taste apparatus" becomes, over the years, extremely sensitive and specialized to the particular saliva which the individual possesses; or these differences in saliva may be congenital or genetic. This being the case, when other saliva is introduced, it is equivalent to water, and no taste sensation results.

As a check on whether saliva influences other tastes, 27 observers were tested with saturated solutions (in water) of saccharin and salt on dry tongues, and on tongues wet with saliva. All of the individuals were able to taste both the salt and the saccharin using wet tongues, but 16 failed to detect the saccharin and nine failed to detect the salt with a dry tongue. Apparently, therefore, saliva aids in many taste sensations, but its effect is most pronounced with P. T. C.

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Sex Influence on Embryonic Death Rate in Chicks

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Thornton (*7*) reported evidence from this laboratory that the death rate in chick embryos up to 5 days of age was greater in females than in males. Landauer and Landauer (*5*) in summary data showed that the sex ratio of chicks at hatching was 48.77. Byerly and Jull (*1*) reported the sex of embryos that died after 9 days of incubation to be 48.59% males. These data would suggest that the mortality rate during this period was higher in females. Hays (*2*) gave the sex ratio in chicks at 8 weeks of age as 50.85% males. Hays (*3*) showed that the primary sex ratio in chickens is about 50–50, with considerable variation between families. In general, observations of different workers suggest that there may be considerable variation between breeds and strains with respect to sex ratio (*6*).

Data collected in the spring of 1949 on the Massachusetts Experiment Station flock of Rhode Island Reds strongly indicate that among embryonic deaths up to 5 days of incubation there is a higher incidence in females than in males. In the fowl the female is the heterogametic sex, and the reduced ratio in females corresponds to the reduced ratio of males reported for most animals where the male is the heterogametic sex.

The data presented in the table include 5450 eggs set in six weekly hatches, including eggs laid from February 5 to March 25, there being a 1-week interval in which eggs were not saved between the third and fourth hatches. A very mild epidemic of bronchitis appeared in the breeding pens soon after the collection of hatching eggs began. This disease outbreak caused a linear decline in production during the period, in contrast to the normal rapid increase expected at this season (*4*). Effects of the disease were observed both on fertility and embryonic death rate. Sex of the chicks was not determined until they were 8 weeks of age, but the postincubation death rate was low in the 3200 chicks retained.

TABLE 1

Hatch	Egg production	Total embryonic mortality %*	Early embryonic mortality %†	Sex ratio at 8 weeks
1	1337 (F5–11)	20.5	19.8	50.0
2	1238 (F12–18)	27.5	28.7	50.0
3	1097 (F19–25)	32.4	55.0	56.6
4	991 (M5–11)	20.8	32.5	52.8
5	948 (M12–18)	24.1	31.1	53.4
6	921 (M19–25)	27.6	38.4	56.5

* Based on fertile eggs.

† Percentage of embryos that died early.

The table shows that total embryonic mortality did not increase greatly through the hatching season, but the early embryonic death rate almost doubled as the season progressed. This observation suggests that the disease virus had a lethal effect which operated early in the development of the chicks. The last column gives the percentage of survivors at 8 weeks of age that were of the male sex. The abnormally high percentage of males from the last four hatches strongly indicates that the majority of embryos that died early must have been females. These data, together with those of Byerly and Jull (*1*), show that the embryonic death rate in females is higher than in males, at all stages of embryonic development.

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Book Reviews

Pharmacology and toxicology of uranium compounds: With a section on the pharmacology and toxicology of fluorine and hydrogen fluoride. (National Nuclear Energy Series, Div. VI, Vols. 1 and 2.) Carl Voegtlin and Harold C. Hodge. (Eds.) New York: McGraw-Hill, 1949. (Illustrated.) Vol. 1: pp. xvii + 524; Vol. II: pp. 525–1084. $10.00.

These volumes are part of the National Nuclear Energy Series prepared as a record of the research work done under the Manhattan Project and the Atomic Energy Commission. They represent the comprehensive experimental studies carried out by a considerable group of investigators in the Division of Pharmacology of the Manhattan Department of the University of Rochester on the pharmacology and toxicology of uranium. Prefaces and forewords outline the history of the volumes, the nature of the problem undertaken, and the proposed attack; only casual mention is made of the peculiar difficulties of war research.

The urgency of the problem—the toxicity of uranium compounds—resulted in the formation of a large organization that sought information of immediate practical value. While the applied science approach was dominant, much work of a more fundamental nature was undertaken in order to understand the nature of uranium poisoning and to provide possible avenues toward diagnosis, prophylaxis, and therapy. The studies utilized several species of animals in order to permit generalization of the conclusions to include man. To encompass the possible modes through which man might become poisoned, experiments were performed with many uranium compounds and the principal modes of experimental exposure: inhalation, ingestion, subcutaneous and intravenous injection, and application to the skin or eye. There are also studies on human exposure to uranium compounds. The characteristic changes of uranium poisoning are presented from clinical, histopathological, and biochemical viewpoints. The distribution and excretion of uranium under various conditions, the nature of acquired tolerance to uranium poisoning, and the effect of uranium compounds on enzymes and proteins were also investigated.

Many of the methods employed were originated or adapted by the Rochester group, and are presented in detail. Most of these might be useful to investigators in other problems in pharmacology and toxicology. This is particularly true of the methods used in the inhalation studies, which are presented in an excellent and exhaustive chapter. Inasmuch as fluorine and hydrogen fluoride are of increasing industrial importance, the chapter on the toxicity of these substances should be especially valuable.

The presentation of the material, both conceptual and factual, is lucid and thorough, and use is made of charts and figures where feasible. Interpretations wander away from facts infrequently, proofreading errors are few, and "scientific shorthand" is kept to a minimum. These volumes were not intended as a textbook, but should be of value to toxicologists and pharmacologists generally. They are the most comprehensive studies on the pharmacology and toxicology of uranium ever published.

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Physikalische Chemie in Medizin und Biologie. (2nd ed.) W. Bladergroen. Basle, Switz.: B. Wepf & Co., 1949. Pp. xxiv + 675. (Illustrated.) 45 Sw. fr.

"Zwischen zwei Stühlen zu sitzen ist sicher keine angenehme Situation," so writes M. Roch, of Geneva, in his introduction to this book. He is referring to the position in which he says many physicians find themselves today in respect to their practice and teaching of medicine as it relates to the applications of physical chemistry. Apparently the basic training of physicians in Switzerland is as devoid of physical chemistry as it is in our own. This book, like many others on the market, has been written mainly in an attempt to rectify this deficit in our medical training program. The author is vice president of Sandoz, Ltd. in Basle, Switzerland.

The first five chapters deal largely with those basic chemical and physicochemical concepts which find an extensive application to biology and medicine. They deal with such topics as the structure of matter, kinetics and energetics, radiations, nuclear physics, and properties of aqueous solutions. Chapter six treats of acid-base equilibrium in the animal body. The next five chapters are concerned chiefly with surface phenomena and colloidal solutions. Two of the five chapters are devoted largely to a description of the basic principles involved and the others mainly to the fine structure of protoplasm, permeability, and osmotic pressure relationships within the animal body. The book concludes with chapters on oxidation reduction potentials and biological oxidations, between which, rather oddly, is sandwiched a chapter on metabolism.

In general, the author appears to have performed a commendable job. His treatment of the various topics is extensive enough to avoid being superficial and he has not refrained from the use of the necessary mathematics. Those who are able to read German with ease will find this book worth consulting when they wish to clarify some aspects of the role of physical chemistry in biology and medicine.

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Scientific Book Register

Adams, Roger *et al.* (Eds.) *Organic reactions.* (Vol. V.) New York: John Wiley, 1949. Pp. viii + 446. $6.00.

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Behrens, Charles F. (Ed.) *Atomic medicine.* New York: Thomas Nelson, 1949. Pp. xiv + 416. (Illustrated.) $7.50.

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English, James, Jr., and Cassidy, Harold G. *Principles of organic chemistry: an introductory text in organic chemistry.* New York: McGraw-Hill, 1949. Pp. xiii + 512. (Illustrated.) $5.00.

Farris, Edmond J., and Griffith, John Q. (Eds.) *The rat in laboratory investigation.* (2nd ed.) Philadelphia: J. B. Lippincott, 1949. Pp. xvi + 542. (Illustrated.) $15.00.

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The New York Meeting, AAAS

December 26–31, 1949

AAAS Special Sessions

One of the features that characterize the Association's Annual Meetings is a series of general lectures and addresses, frequently sponsored by organizations that meet regularly with the AAAS, and open to the general public of the city in which the meeting is held. The series will be continued this year, with several notable additions. All but one of the lectures are scheduled for the Grand Ballroom of the Hotel Statler, the largest available room. Since these sessions are not restricted to registrants, and the capacity of the ballroom is limited, early arrival is advisable.

The presidential address, by retiring president Edmund W. Sinnott, director of the Sheffield Scientific School, Yale University, will be held Wednesday evening, December 28, at the Grand Ballroom of the Hotel Statler, at 8: 00 p.m. His subject will be "Ten Million Scientists." Elvin C. Stakman, President of the Association, will preside. G. B. B. M. Sutherland, official representative of the British Association for the Advancement of Science, and officers of the AAAS will be seated on the platform. Members of the Honorary Reception Committee will have reserved seats. The presidential reception that follows this address is open to all registrants. The speaker, officers of the Association, and members of the Honorary Reception Committee will be in the receiving line.

The address by G. B. B. M. Sutherland, of the British Association for the Advancement of Science, "The Growing Importance of Infrared Studies in Physics, Chemistry, and Biology," will be held in the Grand Ballroom of the Statler, on Wednesday afternoon, December 28, at 4: 30 p.m. An exchange address by an official representative of the BAAS, which antedates the AAAS by 17 years, has come to be traditional, and significant of the ties between scientists throughout the world. This year Dr. Sutherland is professor of physics in the Harrison M. Randall Laboratory of Physics, University of Michigan; last year he was reader in spectroscopy and fellow of Pembroke College in the University of Cambridge. His recent election as Fellow of the Royal Society was for his distinguished work in infrared physics at Cambridge.

The Josiah Willard Gibbs lecturer this year will be Norbert Wiener, of the Massachusetts Institute of Technology, who will speak on "The Mathematics of Sensory Prosthesis." This mathematics lecture, sponsored by the American Mathematical Society, will be held at McMillan Theatre, Columbia University, on Wednesday afternoon, December 28, at 4: 30 p.m.

The National Geographic Society's annual lecture will be held Tuesday afternoon, December 27, at 3: 00 p.m. in the Statler's Grand Ballroom. Those who have attended these illustrated lectures before know their excellence. This year's speaker will be Frank M. Setzler, head curator of the Smithsonian's Department of Anthropology, who was coleader last year of an expedition to Arnhem Land in Australia, sponsored jointly by the National Geographic Society, the Smithsonian Institution, and the Commonwealth of Australia (see *Science*, May 20, page 528). With a sound film in color, Dr. Setzler will describe the customs of the little-known aborigines of Arnhem Land, and also its topography, fauna, and flora.

The Scientific Research Society of America, recently organized by The Society of the Sigma Xi, offers as speaker for its first annual lecture John R. Dunning, Columbia University's distinguished physicist, who will speak on "Recent Advances in Nuclear Physics." George A. Stetson, editor of *Mechanical Engineering*, and chairman of RESA, will preside at this session, which will be held Monday evening, December 26, at 8: 00 p.m. in the Statler's Grand Ballroom.

One of the outstanding features every year is the annual address of The Society of the Sigma Xi. This year it will be made by Theodosius Dobzhansky, Columbia University zoologist and author of *Genetics and origin of species*. Dr. Dobzhansky has recently returned from South America and the subject of his illustrated lecture will be "Evolution in the Tropics." George B. Pegram, vice president of Columbia University and president of The Society of the Sigma Xi, will preside at the session, to be held in the Statler Grand Ballroom, Tuesday evening, December 27, at 8: 00 p.m.

There will be an important forum on "Research and National Security" in the Statler's Grand Ballroom, Thursday, December 29, at 10: 00 a.m. Detlev W. Bronk, president, The Johns Hopkins University, will preside; the speakers will include representatives of the armed forces and the AEC.

AAAS Exhibits

The AAAS Annual Science Exposition, larger and more diversified than ever before—70 exhibitors, 86 booths—will be held throughout the week in the Penn Top and Salle Moderne, on the 18th floor of the Hotel Statler, and is open to all adults. Hours are 2: 00 p.m. to 6: 00 p.m. Monday; 9: 00 a.m. to 6: 00 p.m. Thursday and Friday; 9: 00 a.m. to 9: 00 p.m. Tuesday and Wednesday; and 9: 00 a.m. to 12: 00 m. Saturday. The exhibits will be listed and described in the Preconvention Issue of *Science*.

Science-teaching exhibits will be displayed all day Thursday, December 29, in the Hotel New Yorker's Grand Ballroom. There will be two sets of exhibits: (1) materials and devices found useful in science teaching by science teachers in New York City; and (2) materials of interest to science teachers, arranged by scientific institutions in and near New York City.

Visual displays illustrating the principles of television, set up by the New York Section of the American Institute of Electrical Engineers jointly with AAAS Section M, will occupy the East Room of the Hotel McAlpin for three days, Wednesday, Thursday, and Friday, December 28, 29, and 30.

Exhibits of the American Society of Human Genetics will be on display all week in adjoining Parlors J and F, Hotel Governor Clinton.

Technical demonstrations of three biological societies will be on display: American Society of Parasitologists—Schemerhorn Hall, Rooms 864, 903–913, Columbia University, Wednesday afternoon, December 28, 2: 30–5: 00 p.m.; American Society of Zoologists—Schemerhorn Hall, Rooms 652–654, Columbia University, Thursday afternoon, December 29, beginning 2: 00 p.m.; Genetics Society of America—Schemerhorn Hall, Rooms 903–913, Columbia University, Thursday afternoon, December 29, beginning 2: 00 p.m.

AAAS Symposia

Several symposia, joint meetings, and panel discussions that explore relatively neglected areas of scientific inquiry, or survey current knowledge in a given field, are designated AAAS-sponsored symposia. Such programs are helpful because they summarize the present status of research, focus attention upon critical points, and give direction to further research. Scientists well established in their fields and younger specialists have come to anticipate AAAS symposia and they have become an increasingly important aspect of the annual meetings of the Association. Not infrequently, such papers are gathered into symposium volumes. Typically, these programs originate in the minds of the able officers of the Association's sections and are developed by them, individually or by committees. This year the Symposium Committee is composed of President Elvin C. Stakman, chairman; General Secretary Karl Lark-Horovitz; Walter C. Miles; and Assistant Administrative Secretary, Raymond L. Taylor, secretary.

The problem of scheduling these symposia—several of them requiring four sessions—with a minimum of interference with the regular paper-reading sessions of the participating societies, this year has largely been solved by grouping most of them on two successive days, Thursday and Friday, December 28 and 29. Even this, however, has required the cooperation of the societies. It is planned for 1950 that all Association-sponsored symposia shall be grouped at the beginning or end of the six-day period of the meetings—an obvious advantage to those who may be particularly interested in the sessions of the participating societies or the symposia and no disadvantage to those who elect to stay for both.

The ten Association-sponsored symposia of 1949 comprise:

1. Trends in Modern Science

Tuesday morning, December 27, Grand Ballroom, Hotel New Yorker, at 10: 00 a.m. Arranged jointly by AAAS Cooperative Committee, American Nature Study Society, National Association of Biology Teachers, National Science Teachers Association; *Karl Lark-Horovitz*, head, Department of Physics, Purdue University, and General Secretary of the AAAS, in charge and presiding. Speakers: *Lawrence L. Quill*, head, Department of Chemistry, Michigan State College; *Lincoln V. Domm*, Department of Zoology, University of Chicago; and *Elvin C. Stakman*, chief, Division of Plant Pathology and Botany, University of Minnesota.

2. Science in General Education

Thursday afternoon, December 29, Grand Ballroom, Hotel Statler, at 1: 30 p.m. Arranged by the AAAS Cooperative Committee, *Karl Lark-Horovitz*, head, Department of Physics, Purdue University, in charge and presiding. Speakers: *Earl McGrath*, Commissioner of Education, U. S. Office of Education; *Paul B. Sears*, chairman, Department of Botany, Oberlin College; *Morris Meister*, principal, Bronx High School of Science; and *Karl Lark-Horovitz*, head, Department of Physics, Purdue University.

3. Improvement of Science Instruction on the College Level: A Panel Discussion

Thursday afternoon, December 29, Grand Ballroom, Hotel Statler, 3: 30 p.m. *Elvin C. Stakman*, chief, Division of Plant Pathology and Botany, University of Minnesota, and President of the AAAS, in charge and presiding. Speakers: *James B. Conant*, president, Harvard University; *W. F. Loehwing*, head, Department of Botany, University of Iowa; *Fernandus Payne*, chairman, Department of Zoology, dean of the Graduate School, University of Indiana; and *Alan Gregg*, director of medical science, Rockefeller Foundation.

4. The Present State of Physics

Arranged by *F. S. Brackett*, chief, Low Energy Radiation Biology Section, National Institutes of Health, and Secretary of the AAAS Section B—Physics. Four sessions.

1. Elementary Particles. Thursday afternoon, December 29, Georgian Room, Hotel Statler, at 2: 00 p.m.; *Gregory Breit*, Physics Department, Yale University, presiding. Speakers: *P. Kusch*, Department of Physics, Columbia University; *E. P. Ney*, Physics Department, University of Minnesota; and *Jabez C. Street*, Physics Department, Harvard University.

2. Physics of the Solid State. Friday morning, December 30, Georgian Room, Hotel Statler, at 9: 30 a.m.; *F. S. Brackett*, presiding. Speakers: *Karl Lark-Horovitz*, head, Department of Physics, Purdue University; *John W. Bardeen*, Bell Telephone Laboratories; and *Arthur R. Von Hippel*, Department of Electrical Engineers, Massachusetts Institute of Technology.

3. Chemical Physics. Friday afternoon, December 30, Georgian Room, Hotel Statler, at 1: 30 p.m.; *Sterling Hendricks*, U. S. Bureau of Plant Industry, presiding. Speakers: *Peter W. Debye*, Baker Chemical Laboratory, Cornell University; and *Henry Eyring*, dean, Graduate School, University of Utah.

4. Biophysics. Friday afternoon, December 30, Georgian Room, Hotel Statler, at 3: 30 p.m.; *Kenneth S. Cole*, Naval Medical Center, Bethesda, presiding. Speakers: *Frank Brink, Jr.*, Department of Biophysics, The Johns Hopkins University; and *F. H. Johnson*, Department of Biology, Princeton University.

5. Steroid Hormones and Sex Differentiation in Vertebrates

Friday afternoon, December 30, Grand Ballroom, Hotel Statler, at 2: 00 p.m. Arranged by *J. H. Bodine*, head, Department of Zoology, University of Iowa and Secretary of AAAS Section F—Zoology, and *L. V. Domm*, Whitman Laboratory of Experimental Zoology, University of Chicago. *Roland K. Meyer*, University of Wisconsin, presiding. Speaker: *Emil Witsch*, Department of Zoology, University of Iowa; Discussants: *Clifford Grobstein*, National Cancer Institute, and *W. J. Eversole*, Syracuse University; Speaker: *L. V. Domm*, Whitman Laboratory of Experimental Zoology, University of Chicago; Discussant: *B. H. Willier*, director, Biological Laboratories, The Johns Hopkins University. Speaker: *C. R. Moore*, Whitman Laboratory of Experimental Zoology, University of Chicago; Discussant: *R. K. Burns, Jr.*, Department of Embryology, Carnegie Institution, Baltimore.

6. The Kinsey Report and its Contributions to Related Fields

Friday evening, December 30, Grand Ballroom, Hotel Statler, at 8: 00 p.m. Arranged by *J. H. Bodine*, head, Department of Zoology, University of Iowa, Secretary of AAAS Section F—Zoology; *George W. Corner*, Carnegie Institution, Baltimore, presiding. The speakers on this critique of the Kinsey Report are: *Morris L. Ernst* of the New York law firm, Greenbaum, Wolff and Ernst, for the field of law; *Ralph Linton*, Department of Anthropology, Yale University, for anthropology; *Hugh J. Parry*, the Anti-Defamation League, New York City, for the field of statistics; and *Manfred S. Guttmacher*, chief medical officer, the Court House, Baltimore, Maryland, and also chairman of the American Psychiatric Association Committee on Legal Aspects of Psychiatry, for the field of psychiatry.

7. Botany in the Service of Man: A Panel Discussion

Thursday afternoon, December 29, Winter Garden, Hotel McAlpin, at 2: 00 p.m. Arranged by *Stanley A. Cain*, botanist, Cranbrook Institute of Science, and Secretary of the AAAS Section G—Botany; *William C. Steere*, chairman, Department of Botany, University of Michigan, and Chairman of AAAS Section G, moderator. Speakers: *Hazel K. Stiebeling*, in charge of the Food Economics Section, Bureau of Home Economics, U. S. Department of Agriculture; *S. T. Dana*, dean, School of Forestry and Conservation, University of Michigan; *Gove Hambidge*, special assistant to the director, Food and Agriculture Organization of the United Nations; *Knowles A. Ryerson*, dean of the College of Agriculture, University of California; and *Frans Verdoorn*, editor, *Chronica Botanica*.

8. Nuclear Engineering

Tuesday evening, December 27, Parlor 1, Hotel Statler, at 7: 30 p.m. Arranged jointly by *Frank D. Carvin*, Department of Mechanical Engineering, Illinois Institute of Technology, and Secretary of AAAS Section M—Engineering, and *Irving P. Orens*, chairman of the Graduate Division, Newark College of Engineering; a joint program of Section M and the Newark College of Engineering. *Irving P. Orens*, presiding. *Robert W. Van Houten*, president of the Newark College of Engineering, will deliver an address of welcome. Speakers: *W. R. Woolrich*, dean of engineering, University of Texas and Chairman of AAAS Section M; *K. D. Nichols*, Major-General, U. S. Army; *Conrad P. Straub*, U. S. Health Service, Oak Ridge, Tennessee; and *Irving P. Orens*, chairman, Graduate Division, Newark College of Engineering.

9. Television

Arranged jointly by *Frank D. Carvin*, Department of Mechanical Engineering, Illinois Institute of Technology and Secretary of AAAS Section M—Engineering, and *I. E. Lattimer*, American Telephone and Telegraph Company; a joint program of Section M and the New York Section of Electrical Engineers. Two sessions.

1. Technology of Television. Wednesday evening, December 29, Crystal Room of the Hotel McAlpin, at 8: 00 p.m.; Round Table Discussion. *John V. L. Hogan*, president, Hogan Laboratories, Inc., moderator. Speakers: *John H. Roe*, supervisor, Television Engineering Group, Radio Corporation of America; *R. M. Bowie*, manager, Physics Laboratories, Sylvania Electric Products Company; and *T. T. Goldsmith, Jr.*, director of research, Allan B. DuMont Laboratories.

2. Impact of Television on Society and Future Developments. Thursday evening, December 29, Crystal Room of the Hotel McAlpin, at 8: 00 p.m.; Round Table Discussion. *W. L. Laurence*, science reporter, The New York Times, moderator. Speakers: *Sterling Fisher*, manager of public affairs and education; National Broadcasting Company; *Ricardo Muniz*, general manager, Allan B. DuMont Laboratories; and *Finley Carter*, vice president in charge of engineering, Sylvania Electric Company.

10. The Adrenal Cortex

Arranged by *Gordon K. Moe*, Department of Pharmacology, University of Michigan and Secretary of AAAS Section N—Medical Sciences and Subsection Nm—Medicine. Four sessions.

1. Wednesday morning, December 28, Keystone Room, Hotel Statler, at 9: 30 a.m.; *J. S. L. Browne*, McGill University, presiding. Speakers: *C. H. Li*, University of California; *C. N. H. Long*, Yale University; *J. W. Conn*, University of Michigan; *Floyd R. Skelton*, University of Montreal; *Dwight J. Ingle*, The Upjohn Company; and *G. W. Wooley*, Roscoe B. Jackson Memorial Laboratory.

2. Thursday morning, December 29, Keystone Room, Hotel Statler at 9: 30 a.m.; *D. J. Ingle*, The Upjohn Company, presiding. Speakers: *Abraham White*, University of California; *Frank L. Engel*, Duke University; *Thomas F. Dougherty*, University of Utah; *Burton L. Baker*, University of Michigan; *Roy O. Greep*, Harvard University; *Helen W. Deane*, Harvard University; and *Robert Gaunt*, Syracuse University.

3. Thursday afternoon, December 29, Keystone Room, Hotel Statler, at 2: 00 p.m.; *C. N. H. Long*, Yale University, presiding. Speakers: *Alan Gregg*, Rockefeller Foundation; *Frederic C. Bartter*, Massachusetts General Hospital; *J. S. L. Browne*, McGill University; *Lawrence*

W. Kinsell, University of California; *O. H. Pearson*, Sloan-Kettering Institute; and *L. P. Eliel*, Sloan-Kettering Institute.

4. Thursday evening, December 30, Keystone Room, Hotel Statler, at 7: 30 p.m.; *J. R. Mote*, Armour Laboratories, presiding. Speakers: *E. Venning*, McGill University; *Konrad Dobriner*, Sloan-Kettering Institute; *H. L. Mason*, Mayo Clinic; *R. G. Sprague*, Mayo Foundation; *M. H. Power*, Mayo Foundation; *A. C. Corcoran*, Cleveland Clinic Foundation; *E. S. Gordon*, University of Wisconsin; and *Hudson Hoagland*, Worcester Foundation for Experimental Biology.

NEWS and Notes

Louis W. Hutchins, member of the staff of the Woods Hole Oceanographic Institution, has been appointed director of the Bermuda Biological Station. Dr. Hutchins will still devote part of his time to Woods Hole, where his chief work has been directing Navy-financed studies on organisms causing fouling on marine vessels and structures.

Karl T. Compton has resigned as Chairman of the Research and Development Board of the National Military Establishment because of ill health. Pending the naming of a successor, President Truman announced that the board would be headed, at Dr. Compton's suggestion, by Robert F. Rinehart as deputy chairman.

Alfred H. Hausrath, Jr. has been appointed director of the Cooperative Test Division of Educational Testing Service, Princeton, New Jersey. He was formerly consultant on training and personnel administration for the Foreign Military Assistance Program of the Department of State.

Roscoe F. Sanford has retired after more than 30 years of service as spectroscopist in Pasadena, at the Mt. Wilson and Palomar observatories. Before going to Mt. Wilson, Dr. Sanford had been stationed at observatories in Argentina for three years by the Carnegie Institution and in Chile for four years by Lick Observatory. At Mt. Wilson he pioneered the application of high dispersion to variable and double stars and made notable photographs of the spectra of cool red ''carbon'' stars.

Granville A. Bennett, professor of pathology and chairman of the department, University of Illinois College of Medicine, will deliver the fourth Richard H. Jaffé Memorial Lecture of the Institute of Medicine of Chicago on Friday evening, November 25. His subject will be ''Reactive and Neoplastic Changes in Synovial Tissues.''

John E. Barkley, supervisor of physical chemistry research at Armour Research Foundation of Illinois Institute of Technology, is spending two weeks in London, consulting with British scientists on the latest developments in infrared photocell research. Dr. Barkley has visited several laboratories in England and participated in field tests. He expects to return to the U. S. about November 18.

John M. Brookhart has recently resigned his position as assistant professor of physiology at Northwestern University Medical School to take up duties as associate professor of physiology at the University of Oregon Medical School, Portland, Oregon.

Marshall J. Walker, formerly of the Alleghany Ballistics Laboratory and the National Bureau of Standards, and **Stephen S. Friedland**, University of New Mexico physicist, have joined the staff of the Physics Department of the University of Connecticut. Dr. Friedland is planning to build a mass spectrometer especially adapted for the analysis of biological materials.

Oskar Baudisch, director of research at Saratoga Springs Commission, is spending the winter as a visiting investigator at the Scripps Institution of Oceanography, La Jolla, California. Dr. Baudisch is engaged in the organization of a research program on trace elements in the sea and marine organisms.

Visitors to U. S.

F. C. Bawden, head of the Plant Pathology Department, Rothamsted Experimental Station, England, and author of the standard treatise, *Plant viruses and virus diseases*, will be a visiting lecturer at Yale University during March, 1950. Mr. Bawden will deliver a series of ten lectures on plant viruses under the auspices of the Yale Departments of Plant Science and of Microbiology. Following his residence at Yale, Mr. Bawden will visit laboratories and experiment stations throughout the country. Further information on these lectures may be obtained from Prof. Henry P. Treffers, Director of Graduate Studies in Microbiology, Yale University.

Luis Molina Johnson, director of the training station in tropical diseases in Boca del Rio, Vera Cruz, spent a week in Washington, D. C. consulting with the World Health Organzation. Now in Ecuador, he will act as WHO consultant on maternal and child health.

Visitors at the National Bureau of Standards during the week of October 31–November 4 included: **Augusto Falcon de Gyves**, engineer with the Geophysics Institute of the University of Mexico; **G. G. Graham**, chief, technical services, National Film Board of Canada; **Ricardo Monges Lopez**, director, Geophysics Institute of the University of Mexico; **T. Mylvaganam**, irrigation engineer, Irrigation Laboratory, Department of Irrigation, Colombo, Ceylon; **R. A. Smith**, superintendent of Physics Department, Telecommunications Research Establishment, Gt. Malvern, England; **Alfonso Vaca Alatone**, engineer with the Geophysics Institute of the University of Mexico; and **Rafael J. Larnarca, Albino del Rosario,** and **Calixto S. Rozal,** members of the Philippine Coast and Geodetic Survey, Manila, Philippine Islands.

Grants and Awards

Irving Langmuir, associate director of the General Electric Research Laboratory, recently became the second American scientist to receive the **Mascart Medal,** awarded triennially by the Société Francaise des Electriciens to a scholar or engineer "who is distinguished by an ensemble of works on pure or applied electricity." The American Institute of Electrical Engineers made the presentation of the award, for the year 1948, in behalf of the French organization.

The Gordon McKay Endowment, established in 1909 "to promote applied science" at Harvard University, granted $8,626,506 to the university this month, bringing to a total of $15,766,755 the amount Harvard has received from this source. The Faculty of Arts and Sciences will receive $2,000,000 of the latest grant, with the remainder to be allocated following a review of the entire Harvard program in applied science and engineering.

The Roebling Medal was awarded for distinguished achievement in the field of mineralogy to Herbert E. Merwin, Geophysical Laboratory, Washington, D. C., at the thirtieth annual meeting of the Mineralogical Society of America in El Paso, Texas, November 10–12.

The first John H. Potts Memorial Award was given to Harry F. Olson, director of the RCA Acoustical Research Laboratory at Princeton, New Jersey, by the Audio Engineering Society on October 28. The medal was given to Dr. Olson "for outstanding accomplishments in the field of audio engineering." He is the author of *Elements of acoustical engineering* and *Dynamical analogies.*

The 1949 Sedgwick Memorial Medal has been granted by the American Public Health Association to Henry F. Vaughan, dean of the School of Public Health, University of Michigan. Dr. Vaughan was active in the organization of the National Sanitation Foundation.

The Sharp and Dohme Award of the American Physiological Society has been granted to Wallace O. Fenn, professor of physiology at the University of Rochester. In addition to a stipend, the award entitles Dr. Fenn to represent the society at the 18th International Physiological Congress in Copenhagen, in August, 1950.

The Ipatieff Prize in Chemistry for 1950 has been awarded to Herman E. Ries, Jr., research chemist at the Sinclair Refining Company Research Laboratories, Harvey, Illinois. The $3,000 award is given every three years to a scientist under 40 for achievement in the study of catalysis or high pressure.

Fellowships

General Electric Company is accepting applications for the year 1950–51 for its **Charles A. Coffin Fellowships** in electricity, physics, and physical chemistry, and its **Gerard Swope Fellowships** in engineering, industrial management, and the physical sciences. The fellowships, made from the corporation's Educational Fund, include a stipend up to $1,500, and, if necessary, an additional grant of $500 for special equipment. Loans up to $1,000 may also be granted. Applications must be filed before *January 1, 1950,* and are available through technical schools and universities or from A. D. Marshall, Secretary, General Electric Educational Fund, Schenectady, New York.

The National Research Council has announced the availability of **RCA Predoctoral Fellowships in Electronics** for 1950. These fellowships, supported by the Radio Corporation of America, are designed to give special graduate training and experience in research to young men and women who have demonstrated marked ability in electronics, either as a branch of electrical or radio engineering, or in that field of physics which treats the behavior of electrons in conductance phenomena.

Applicants should have training in electronics equivalent to that represented by one year beyond the bachelor's degree, in a university of recognized merit in this field, and must be citizens of the U. S.

Fellowships will be awarded at a regular meeting of the RCA Fellowship Board in March, 1950. Applications must be filed on or before *January 10, 1950.* Unless otherwise arranged, tenure will begin in September, 1950.

National Research Fellowships in the Natural Sciences will be continued in 1950. These fellowships, which are being offered for the 31st consecutive year, are supported by the Rockefeller Foundation to promote fundamental research in the natural sciences. Fellowships are available in the fields of mathematics, astronomy, physics, chemistry, geology, geophysics, paleontology, physical geography, botany, zoology, biochemistry, biophysics, agriculture, forestry, anthropology, and psychology.

These fellowships are awarded to citizens of the U. S. or of Canada, and generally only to persons under 35 years of age. The requirements for the doctorate must have been completed prior to assuming the fellowship, and the fellow must have demonstrated a high order of ability in research.

Fellowships will be awarded by the Natural Sciences Fellowship Board at its meeting in March, 1950. Applications to be considered at this meeting should be filed on or before *January 1, 1950.* Tenure of the fellowship may begin at any appropriate time after the board meeting.

Further information concerning these fellowship programs may be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C.

Colleges and Universities

California Institute of Technology's new hypersonic wind tunnel permits tests at a speed of more than ten times the velocity of sound. A guided missile designed with the aid of the new tunnel could travel a distance of 7,600 miles in about an hour, well above the top rocket speed so far reported. The Mach 10 tunnel, operated under Army Ordnance Department contract, will be used to obtain basic information about the design, performance, and instrumentation of tunnels for hypersonic speeds.

Ohio State University's new Institute for Research in Vision will have as codirectors Glenn A. Fry, director of the School of Optometry, and Arthur M. Culler, chairman of the Department of Ophthalmology. The new research center will coordinate research in other fields besides optometry and ophthalmology. Among these will be physics, psychology, physiology, pediatrics, bacteriology, anatomy, veterinary medicine, and zoology.

A children's neurological ward has been opened at the Illinois Neuropsychiatric Institute, Chicago. The medical staff for the ward will be provided by the **College of Medicine of the University of Illinois.** Eric Oldberg, professor of neurology and neurological surgery and head of the department, has been appointed supervisor.

The University of Maine dedicated two new buildings last week. The Engineering Building will house the Civil and Mechanical Engineering Departments, a highway testing laboratory, and geology classrooms. The Plant Science Building will be headquarters for the Departments of Botany and Entomology, Agronomy, Horticulture and Forestry, and will also provide space for the Agricultural Experiment Station laboratories and the Maine Extension Service.

Industrial Laboratories

Bryan C. Redmon has been appointed assistant director of organic chemical research by **U. S. Industrial Chemicals, Inc.,** at the company's Baltimore laboratories. Dr. Redmon was formerly with American Cyanamid Company and on the faculty of the University of Massachusetts.

The U. S. Atomic Energy Commission has approved the export of a two-Mev electrostatic x-ray generator, for use in the treatment of cancer, to the Westminster Hospital, St. Johns Gardens, London. The fourth to be approved for export to England for radiation therapeutic uses during the past two years, the generator will be manufactured by the **High Voltage Engineering Corporation,** Cambridge, Massachusetts.

The Sahyun Laboratories for research in medicinal chemistry, nutrition, biochemistry, and pharmaceutical products were opened recently at Santa Barbara, California, by Melville Sahyun, formerly vice president and director of research of the Frederick Stearns and Company Division of Sterling Drug, Inc.

Meetings and Elections

The fifth annual conference of the Georgia Section of the American Chemical Society will be held at the Georgia Institute of Technology, Atlanta on November 18. Twenty-nine papers will be presented by scientists from Emory University, Georgia Institute of Technology, Wesleyan College, the Georgia Experiment Station, and the University of Georgia.

A series of meetings devoted to the fundamental problems of growth and malignancy will be presented throughout the winter by the Department of Pathology of the College of Medicine at the University of Vermont. All meetings will be at 8 p.m. in the university's Fleming Museum in Burlington. Charles B. Huggins, professor of surgery, University of Chicago, will be the speaker at the first meeting on December 2 with a lecture on "Serum Proteins in Cancer."

Other speakers scheduled are Leonell C. Strong, professor of anatomy at Yale School of Medicine, to speak January 5 on "Genetics and Cancer"; Albert J. Tannenbaum, February 9, "Diet and Cancer"; Van R. Potter, professor of oncology, University of Wisconsin Medical School, March 2, "Enzymes, Growth, and Cancer"; Roy Hertz, chief of the Endocrinology Section of the National Cancer Institute, March 30, "Vitamin-Hormone Interrelationships Affecting Tissue Growth"; and Robert E. Stowell, professor of oncology, University of Kansas School of Medicine, May 4, "Nucleoproteins, Growth, and Cancer."

The Association of Urban Universities, at its 35th annual meeting in Chicago on October 31, elected as president James Creese, president of the Drexel Institute of Technology, and as vice president David A. Lockmiller, president of the University of Chattanooga, and reelected David D. Henry, president of Wayne University, as secretary-treasurer.

The National Tuberculosis Association will hold its 46th annual meeting April 24–28, 1950, at the Hotel Statler, Washington, D. C. Meeting concurrently with the NTA will be its Medical Section, the American Trudeau Society, and the National Conference of Tuberculosis Secretaries. The medical sessions will be devoted to the chemotherapy of tuberculosis, surgical aspects of tuberculosis, laboratory investigations, and nontuberculous diseases of the chest. Further information may be obtained by writing the National Tuberculosis Association, 1790 Broadway, New York City 19.

The Biennial Congress of the International Society of Hematology will be held August 21–26, 1950, at the University of Cambridge in England. The Program Committee is considering titles for papers and exhibits to be presented. Material should be submitted as soon as possible to I. Davidsohn, Mt. Sinai Hospital, Chicago, or S. Mettier, University of California, San Francisco.

The Engineering Foundation elected the following officers at the annual meeting of its board: Boris A. Bakhmeteff, consulting engineer and professor of civil engineering, Columbia University, chairman; and C. G. Suits, of General Electric Company, vice chairman. Frank T. Sisco was reelected technical director, and John H. R. Arms, secretary.

Dr. Bakhmeteff was also appointed chairman of the Executive Committee, whose other members are John H. R. Arms, C. G. Suits, A. B. Kinzel, vice president of the Union Carbide and Carbon Research Laboratories, Inc., Herman Weisberg, mechanical engineer in the Electrical Engineering Department of the Public Service Company of New Jersey, and D. A. Quarles, vice president of the Bell Telephone Laboratories, Inc.

The Research Procedure Committee also will be headed by Dr. Bakhmeteff. Other members are E. R. Kaiser, assistant director of research, Bituminous Coal Research, Inc., Herman Weisberg, and C. G. Suits.

Deaths

Gebhard Stegeman, 59, professor of chemistry at the University of Pittsburgh, and a member of the staff since 1919, died of a heart attack September 5 at his home in Pittsburgh. Dr. Stegeman's most recent research was on the specific heat of sugar.

Earl O. Wilson, 59, professor of industrial and engineering chemistry at Yenching University, Peiping, for 21 years, died September 30 at Covina, California. During the war, Dr. Wilson was interned by the Japanese at Weihsien in Shantung and was later repatriated. He retired in 1944 because of ill health.

Sterling Henry Diggs, chemist, died at his home in Charlottesville, Virginia, on September 5, at the age of 70. Dr. Diggs was director of research for the Standard Oil Company of Indiana at Casper, Wyoming, from 1923 until his retirement in 1940.

Royall O. Davis, 69, administrative assistant in the Soils Division of the Agriculture Department's Bureau of Plant Industry died October 30 of a heart attack. During World War II, Dr. Davis conducted research for the U. S. Army on the fire and explosion hazards of ammonium nitrate.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has submitted the following list of wanted chemicals: berbamine; isatin chloride; jervine; 1,3 - bis - (3 - methyl - 4 - nitro - 5 - pyrazolyl)-1,2,4-triazole; zinc carbide; 1,8-diiodooctane; 1,9-diiodononane; 4-bromocyclohexanone; 4-methyl - 4 - bromocyclohexanone; 5 - aminocaproic acid; 7-aminocaprylic acid; 4,6-diaminoquinaldine; difluorochloroacetic acid; *p*-aminohexahydrobenzoic acid; 4-hydroxymethylimidazole; pyridine-3,5-dicarboxylic acid; 2,5 - dimercaptothiodiazole; sphaerophorin; atraric acid; and L-α-glycerylphosphorylcholine.

Edward Pyddoke, curator of the Sussex Archaeological Society in England, informs *Science* that he is searching for archaeological and paleontological material excavated from Kent's Cavern, Torquay, Devonshire, during the 19th century. There is no complete catalogue and he believes much of the material has found its way into museums and private collections. Dr. Pyddoke is compiling an illustrated monograph at the request of the British Association for the Advancement of Science. Communications should be sent to him in care of the Sussex Archaeological Society, Barbican House, Lewes, England.

The Mathematics Department of **Harvard University** expects to have one or two vacancies in the rank of Benjamin Peirce Instructor beginning in the fall of 1950. Appointments are for a maximum period of three years. Applications should reach the department prior to *March 15, 1950.*

Units of Radioactivity. In November, 1947, a joint committee of the Divisions of Chemistry and Chemical Technology and of Mathematical and Physical Sciences of the National Research Council was appointed to make recommendations regarding standards and units of radioactivity. This committee unanimously adopted the recommendations quoted below. The committee would like to point out that these recommendations effectively divorce the curie from the disintegration rate of radium by assigning to the former an arbitrary magnitude (3.7×10^{10} dis/sec) approximately equal to the disintegration rate of radium. This arbitrary figure is therefore not influenced by any future revisions of the generally accepted disintegration rate of radium. This recommendation has been submitted to the Joint Commission on Standards, Units, and Constants of Radioactivity of the International Unions of Chemistry and Physics for the purpose of obtaining international agreement.

This changes, slightly, the meaning of the curie when applied to radium. For example, 1 curie of radon is no longer, on the basis of these recommendations, the amount in equilibrium with 1 gram of radium, but is the amount undergoing 3.7×10^{10} disintegrations per second. Similarly, 1 mg and 1 mc of radium are no longer rigorously synonymous. This distinction has a number of precedents in physics; for example, the international ampere, now abolished, was not quite equal to the absolute ampere and the angstrom unit is nearly, but not quite, equal to 1000 x-units.

"**curie** The curie should be defined as that quantity of any radioactive species (radioisotope) undergoing exactly 3.700×10^{10} disintegrations per second."

"**rutherford** The rutherford should be defined as that quantity of any radioactive species (radioisotope) undergoing 10^6 disintegrations per second."

"**rhm** For the quantitative comparison of radioactive sources emitting gamma rays, for which disintegration rates cannot be determined, the *roentgen per hour at one meter* (rhm) is recommended. This is not essentially a new unit, since all units involved are well established, explicitly defined, and are in common usage."

The recommendation of this latter unit is a practical step to insure that, by its use, gamma ray measurements are so made with instruments and under such conditions that measurements on a given isotope (nuclear species) made in any laboratory will be directly comparable with similar measurements made in other laboratories. This will result if the procedures used comply with the definition of the unit; that is, a source is 1 rhm if it produces 1 roentgen per hour at a distance of 1 meter.

L. F. Curtiss, *Chairman*,
R. D. Evans, Warren Johnson,
Glenn T. Seaborg

Sickle Cell Anemia, a Molecular Disease[1]

Linus Pauling, Harvey A. Itano,[2] S. J. Singer,[2] and Ibert C. Wells[3]

Gates and Crellin Laboratories of Chemistry,
California Institute of Technology, Pasadena, California[4]

THE ERYTHROCYTES of certain individuals possess the capacity to undergo reversible changes in shape in response to changes in the partial pressure of oxygen. When the oxygen pressure is lowered, these cells change their forms from the normal biconcave disk to crescent, holly wreath, and other forms. This process is known as sickling. About 8 percent of American Negroes possess this characteristic; usually they exhibit no pathological consequences ascribable to it. These people are said to have sicklemia, or sickle cell trait. However, about 1 in 40 (*4*) of these individuals whose cells are capable of sickling suffer from a severe chronic anemia resulting from excessive destruction of their erythrocytes; the term sickle cell anemia is applied to their condition.

The main observable difference between the erythrocytes of sickle cell trait and sickle cell anemia has been that a considerably greater reduction in the partial pressure of oxygen is required for a major fraction of the trait cells to sickle than for the anemia cells (*11*). Tests *in vivo* have demonstrated that between 30 and 60 percent of the erythrocytes in the venous circulation of sickle cell anemic individuals, but less than 1 percent of those in the venous circulation of sicklemic individuals, are normally sickled. Experiments *in vitro* indicate that under sufficiently low oxygen pressure, however, all the cells of both types assume the sickled form.

The evidence available at the time that our investigation was begun indicated that the process of sickling might be intimately associated with the state and the nature of the hemoglobin within the erythrocyte. Sickle cell erythrocytes in which the hemoglobin is combined with oxygen or carbon monoxide have the biconcave disk contour and are indistinguishable in that form from normal erythrocytes. In this condition they are termed promeniscocytes. The hemoglobin appears to be uniformly distributed and randomly oriented within normal cells and promeniscocytes, and no birefringence is observed. Both types of cells are very flexible. If the oxygen or carbon monoxide is removed, however, transforming the hemoglobin to the uncombined state, the promeniscocytes undergo sickling. The hemoglobin within the sickled cells appears to aggregate into one or more foci, and the cell membranes collapse. The cells become birefringent (*11*) and quite rigid. The addition of oxygen or carbon monoxide to these cells reverses these phenomena. Thus the physical effects just described depend on the state of combination of the hemoglobin, and only secondarily, if at all, on the cell membrane. This conclusion is supported by the observation that sickled cells when lysed with water produce discoidal, rather than sickle-shaped, ghosts (*10*).

It was decided, therefore, to examine the physical and chemical properties of the hemoglobins of individuals with sicklemia and sickle cell anemia, and to compare them with the hemoglobin of normal individuals to determine whether any significant differences might be observed.

EXPERIMENTAL METHODS

The experimental work reported in this paper deals largely with an electrophoretic study of these hemoglobins. In the first phase of the investigation, which concerned the comparison of normal and sickle cell anemia hemoglobins, three types of experiments were performed: 1) with carbonmonoxyhemoglobins; 2) with uncombined ferrohemoglobins in the presence of dithionite ion, to prevent oxidation to methemoglobins; and 3) with carbonmonoxyhemoglobins in the presence of dithionite ion. The experiments of type 3 were performed and compared with those of type 1 in order to ascertain whether the dithionite ion itself causes any specific electrophoretic effect.

Samples of blood were obtained from sickle cell anemic individuals who had not been transfused within three months prior to the time of sampling. Stroma-free concentrated solutions of human adult hemoglobin were prepared by the method used by Drabkin (*3*). These solutions were diluted just before use with the appropriate buffer until the hemoglobin concentrations were close to 0.5 grams per 100 milliliters, and then were dialyzed against large volumes of these buffers for 12 to 24 hours at 4° C. The buffers for the experiments of types 2 and 3 were prepared by adding 300 ml of 0.1 ionic strength sodium dithionite solution to 3.5 liters of 0.1 ionic strength buffer. About 100 ml of 0.1 molar NaOH was then added to bring the pH of the buffer back to its original value. Ferrohemoglobin solutions were prepared by diluting the concentrated solutions with this dithionite-containing buffer and dialyzing against it under a nitrogen atmosphere. The hemoglobin solutions for the experiments of type 3 were made up similarly, except that they were saturated with carbon monoxide after dilution and were dialyzed under a carbon monoxide atmosphere. The dialysis bags were kept in continuous motion in the buffers by means of a stirrer with a mercury seal to prevent the escape of the nitrogen and carbon monoxide gases.

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[1] This research was carried out with the aid of a grant from the United States Public Health Service. The authors are grateful to Professor Ray D. Owen, of the Biology Division of this Institute, for his helpful suggestions. We are indebted to Dr. Edward R. Evans, of Pasadena, Dr. Travis Winsor, of Los Angeles, and Dr. G. E. Burch, of the Tulane University School of Medicine, New Orleans, for their aid in obtaining the blood used in these experiments.

[2] U. S. Public Health Service postdoctoral fellow of the National Institutes of Health.

[3] Postdoctoral fellow of the Division of Medical Sciences of the National Research Council.

[4] Contribution No. 1333.

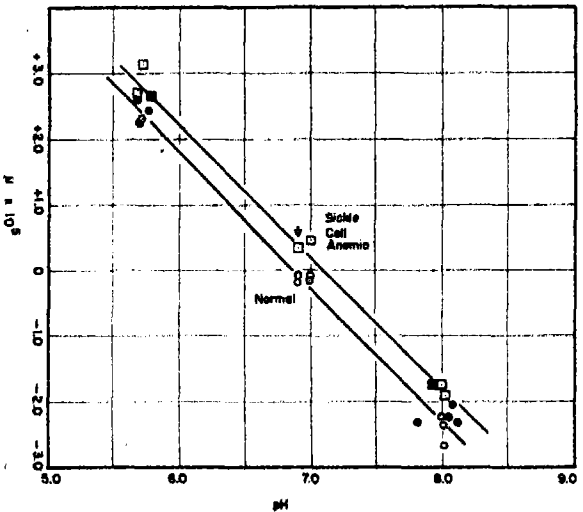

FIG. 1. Mobility(μ)-pH curves for carbonmonoxyhemoglobins in phosphate buffers of 0.1 ionic strength. The black circles and black squares denote the data for experiments performed with buffers containing dithionite ion. The open square designated by the arrow represents an average value of 10 experiments on the hemoglobin of different individuals with sickle cell anemia. The mobilities recorded in this graph are averages of the mobilities in the ascending and descending limbs.

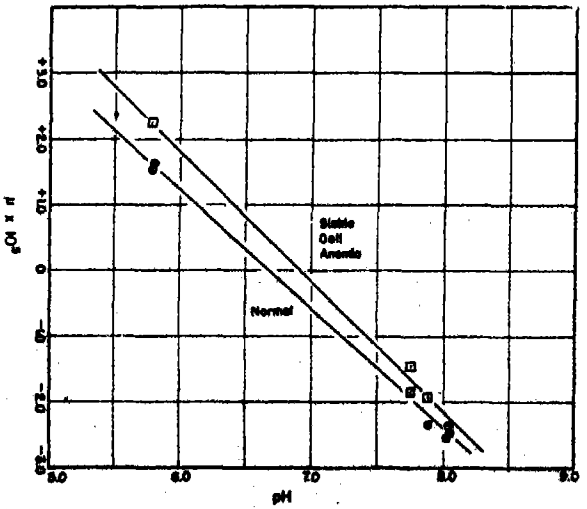

FIG. 2. Mobility(μ)-pH curves for ferrohemoglobins in phosphate buffers of 0.1 ionic strength containing dithionite ion. The mobilities recorded in the graph are averages of the mobilities in the ascending and descending limbs.

The experiments were carried out in the modified Tiselius electrophoresis apparatus described by Swingle (*14*). Potential gradients of 4.8 to 8.4 volts per centimeter were employed, and the duration of the runs varied from 6 to 20 hours. The pH values of the buffers were measured after dialysis on samples which had come to room temperature.

RESULTS

The results indicate that a significant difference exists between the electrophoretic mobilities of hemoglobin derived from erythrocytes of normal individuals and from those of sickle cell anemic individuals. The two types of hemoglobin are particularly easily distinguished as the carbonmonoxy compounds at pH 6.9 in phosphate buffer of 0.1 ionic strength. In this buffer the sickle cell anemia carbonmonoxyhemoglobin moves as a positive ion, while the normal compound moves as a negative ion, and there is no detectable amount of one type present in the other.[4] The hemoglobin derived from erythrocytes of individuals with sicklemia, however, appears to be a mixture of the normal hemoglobin and sickle cell anemia hemoglobin in roughly equal proportions. Up to the present time the hemoglobins of 15 persons with sickle cell anemia, 8 persons with sicklemia, and 7 normal adults have been examined. The hemoglobins of normal adult white and negro individuals were found to be indistinguishable.

The mobility data obtained in phosphate buffers of 0.1 ionic strength and various values of pH are summarized in Figs. 1 and 2.[5]

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[4] Occasionally small amounts (less than 5 percent of the total protein) of material with mobilities different from that of either kind of hemoglobin were observed in these uncrystallized hemoglobin preparations. According to the observations of Stern, Reiner, and Silber (*12*) a small amount of a component with a mobility smaller than that of oxyhemoglobin is present in human erythrocyte hemolyzates.

[5] The results obtained with carbonmonoxyhemoglobins with and without dithionite ion in the buffers indicate that the dithionite ion plays no significant role in the electrophoretic properties of the proteins. It is therefore of interest that ferrohemoglobin was found to have a lower isoelectric point in phosphate buffer than carbonmonoxyhemoglobin. Titration studies have indicated (*5*, *6*) that oxyhemoglobin (similar in electrophoretic properties to the carbonmonoxy compound) has a lower isoelectric point than ferrohemoglobin in

The isoelectric points are listed in Table 1. These results prove that the electrophoretic difference between normal hemoglobin and sickle cell anemia hemoglobin exists in both ferrohemoglobin and carbonmonoxyhemoglobin. We have also performed several experiments in a buffer of 0.1 ionic strength and pH 6.52 containing 0.08 M NaCl, 0.02 M sodium cacodylate, and 0.0083 M cacodylic acid. In this buffer the average mobility of sickle cell anemia carbonmonoxyhemoglobin is 2.63×10^{-5}, and that of normal carbonmonoxyhemoglobin is 2.23×10^{-5} cm/sec per volt/cm.[6]

TABLE 1

ISOELECTRIC POINTS IN PHOSPHATE BUFFER, $\mu = 0.1$

Compound	Normal	Sickle cell anemia	Difference
Carbonmonoxyhemoglobin	6.87	7.09	0.22
Ferrohemoglobin	6.87	7.09	0.22

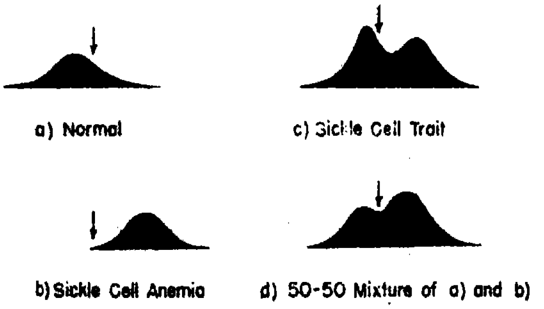

FIG. 3. Longsworth scanning diagrams of carbonmonoxyhemoglobins in phosphate buffer of 0.1 ionic strength and pH 6.90 taken after 20 hours' electrophoresis at a potential gradient of 4.78 volts/cm.

These experiments with a buffer quite different from phosphate buffer demonstrate that the difference between the hemoglobins is essentially independent of the buffer ions.

Typical Longsworth scanning diagrams of experiments with normal, sickle cell anemia, and sicklemia carbonmonoxyhemoglobins, and with a mixture of the first two compounds, all in phosphate buffer of pH 6.90 and ionic strength 0.1, are reproduced in Fig. 3. It is apparent from this figure that the sicklemia material contains less than 50 percent of the anemia component. In order to determine this quantity accurately some experiments at a total protein concentration of 1 percent were performed with known mixtures of sickle cell anemia and normal carbonmonoxyhemoglobins in the cacodylate-sodium chloride buffer of 0.1 ionic strength and pH 6.52 described above. This buffer was chosen in order to minimize the anomalous electrophoretic effects observed in phosphate buffers (*7*). Since the two hemoglobins were incompletely resolved after 15 hours of electrophoresis under a potential gradient of 2.79 volts/cm, the method of Tiselius and Kabat (*16*) was employed to allocate the areas under the peaks in the electrophoresis diagrams to the two components. In Fig. 4 there is plotted the percent of the anemia component calculated from the areas so obtained against the percent of that component in the known mixtures. Similar experiments were performed with a solution in which the hemoglobins of 5 sicklemic individuals were pooled. The relative concentrations of the two hemoglobins were calculated from the electrophoresis diagrams, and the actual proportions were then determined from the plot of Fig. 4. A value of 39 percent for the amount of the sickle cell anemia component in the sicklemia hemoglobin was arrived at in this manner. From the experiments we have performed thus far it appears that this value does not vary greatly from one sicklemic individual to another, but a more extensive study of this point is required.

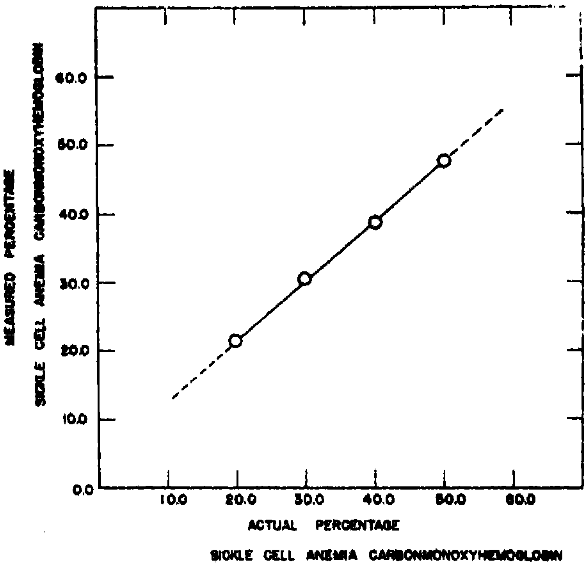

FIG. 4. The determination of the percent of sickle cell anemia carbonmonoxyhemoglobin in known mixtures of the protein with normal carbonmonoxyhemoglobin by means of electrophoretic analysis. The experiments were performed in a cacodylate sodium chloride buffer described in the text.

Up to this stage we have assumed that one of the two components of sicklemia hemoglobin is identical with sickle cell anemia hemoglobin and the other is identical with the normal compound. Aside from the

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the absence of other ions. These results might be reconciled by assuming that the ferrous iron of ferrohemoglobin forms complexes with phosphate ions which cannot be formed when the iron is combined with oxygen or carbon monoxide. We propose to continue the study of this phenomenon.

[6] The mobility data show that in 0.1 ionic strength cacodylate buffers the isoelectric points of the hemoglobins are increased about 0.5 pH unit over their values in 0.1 ionic strength phosphate buffers. This effect is similar to that observed by Longsworth in his study of ovalbumin (*7*).

genetic evidence which makes this assumption very probable (see the discussion section), electrophoresis experiments afford direct evidence that the assumption is valid. The experiments on the pooled sicklemia carbonmonoxyhemoglobin and the mixture containing 40 percent sickle cell anemia carbonmonoxyhemoglobin and 60 percent normal carbonmonoxyhemoglobin in the cacodylate-sodium chloride buffer described above were compared, and it was found that the mobilities of the respective components were essentially identical.[7] Furthermore, we have performed experiments in which normal hemoglobin was added to a sicklemia preparation and the mixture was then subjected to electrophoretic analysis. Upon examining the Longsworth scanning diagrams we found that the area under the peak corresponding to the normal component had increased by the amount expected, and that no indication of a new component could be discerned. Similar experiments on mixtures of sickle cell anemia hemoglobin and sicklemia preparations yielded similar results. These sensitive tests reveal that, at least electrophoretically, the two components in sicklemia hemoglobin are identifiable with sickle cell anemia hemoglobin and normal hemoglobin.

DISCUSSION

1) *On the Nature of the Difference between Sickle Cell Anemia Hemoglobin and Normal Hemoglobin*: Having found that the electrophoretic mobilities of sickle cell anemia hemoglobin and normal hemoglobin differ, we are left with the considerable problem of locating the cause of the difference. It is impossible to ascribe the difference to dissimilarities in the particle weights or shapes of the two hemoglobins in solution: a purely frictional effect would cause one species to move more slowly than the other throughout the entire pH range and would not produce a shift in the isoelectric point. Moreover, preliminary velocity ultracentrifuge[8] and free diffusion measurements indicate that the two hemoglobins have the same sedimentation and diffusion constants.

The most plausible hypothesis is that there is a difference in the number or kind of ionizable groups in the two hemoglobins. Let us assume that the only groups capable of forming ions which are present in carbonmonoxyhemoglobin are the carboxyl groups in the heme, and the carboxyl, imidazole, amino, phenolic hydroxyl, and guanidino groups in the globin. The number of ions nonspecifically adsorbed on the two proteins should be the same for the two hemoglobins under comparable conditions, and they may be neglected for our purposes. Our experiments indicate that the net number of positive charges (the total number of cationic groups minus the number of anionic groups) is greater for sickle cell anemia hemoglobin than for normal hemoglobin in the pH region near their isoelectric points.

According to titration data obtained by us, the acid-base titration curve of normal human carbonmonoxyhemoglobin is nearly linear in the neighborhood of the isoelectric point of the protein, and a change of one pH unit in the hemoglobin solution in this region is associated with a change in net charge on the hemoglobin molecule of about 13 charges per molecule. The same value was obtained by German and Wyman (*5*) with horse oxyhemoglobin. The difference in isoelectric points of the two hemoglobins under the conditions of our experiments is 0.23 for ferrohemoglobin and 0.22 for the carbonmonoxy compound. This difference corresponds to about 3 charges per molecule. With consideration of our experimental error, sickle cell anemia hemoglobin therefore has 2–4 more net positive charges per molecule than normal hemoglobin.

Studies have been initiated to elucidate the nature of this charge difference more precisely. Samples of porphyrin dimethyl esters have been prepared from normal hemoglobin and sickle cell anemia hemoglobin. These samples were shown to be identical by their x-ray powder photographs and by identity of their melting points and mixed melting point. A sample made from sicklemia hemoglobin was also found to have the same melting point. It is accordingly probable that normal and sickle cell anemia hemoglobin have different globins. Titration studies and amino acid analyses on the hemoglobins are also in progress.

2) *On the Nature of the Sickling Process*: In the introductory paragraphs we outlined the evidence which suggested that the hemoglobins in sickle cell anemia and sicklemia erythrocytes might be responsible for the sickling process. The fact that the hemoglobins in these cells have now been found to be different from that present in normal red blood cells makes it appear very probable that this is indeed so.

We can picture the mechanism of the sickling process in the following way. It is likely that it is the globins rather than the hemes of the two hemoglobins that are different. Let us propose that there is a surface region on the globin of the sickle cell anemia, hemoglobin molecule which is absent in the normal molecule and which has a configuration complementary to a different region of the surface of the hemoglobin molecule. This situation would be somewhat analogous to that which very probably exists in antigen-antibody reactions (*9*). The fact that sickling occurs only when the partial pressures of oxygen and carbon monoxide are low suggests that one of these sites is very near to the iron atom of one or more of the hemes, and that when the iron atom is combined with either one of these gases, the complementariness of the two structures is considerably diminished. Under the appropriate conditions, then, the sickle cell anemia hemoglobin molecules might be capable of interacting with one another at these sites sufficiently to cause at least a partial alignment of the molecules within the cell, resulting in the erythrocyte's becoming birefringent, and the cell membrane's being distorted to accommodate the now relatively rigid structures within its confines. The addition of oxygen or carbon monoxide to the cell might reverse these effects by disrupting some of the weak bonds between the hemoglobin molecules in favor of the bonds formed between gas molecules and iron atoms of the hemes.

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[7] The patterns were very slightly different in that the known mixture contained 1 percent more of the sickle cell anemia component than did the sickle cell trait material.

[8] We are indebted to Dr. M. Moskowitz, of the Chemistry Department, University of California at Berkeley, for performing the ultracentrifuge experiments for us.

Since all sicklemia erythrocytes behave more or less similarly, and all sickle at a sufficiently low oxygen pressure (*11*), it appears quite certain that normal hemoglobin and sickle cell anemia hemoglobin coexist within each sicklemia cell; otherwise there would be a mixture of normal and sickle cell anemia erythrocytes in sicklemia blood. We might expect that the normal hemoglobin molecules, lacking at least one type of complementary site present on the sickle cell anemia molecules, and so being incapable of entering into the chains or three-dimensional frameworks formed by the latter, would interfere with the alignment of these molecules within the sicklemia erythrocyte. Lower oxygen pressures, freeing more of the complementary sites near the hemes, might be required before sufficiently large aggregates of sickle cell anemia hemoglobin molecules could form to cause sickling of the erythrocytes.

This is in accord with the observations of Sherman (*11*), which were mentioned in the introduction, that a large proportion of erythrocytes in the venous circulation of persons with sickle cell anemia are sickled, but that very few have assumed the sickle forms in the venous circulation of individuals with sicklemia. Presumably, then, the sickled cells in the blood of persons with sickle cell anemia cause thromboses, and their increased fragility exposes them to the action of reticulo-endothelial cells which break them down, resulting in the anemia (*1*).

It appears, therefore, that while some of the details of this picture of the sickling process are as yet conjectural, the proposed mechanism is consistent with experimental observations at hand and offers a chemical and physical basis for many of them. Furthermore, if it is correct, it supplies a direct link between the existence of "defective" hemoglobin molecules and the pathological consequences of sickle cell disease.

3) *On the Genetics of Sickle Cell Disease*: A genetic basis for the capacity of erythrocytes to sickle was recognized early in the study of this disease (*4*). Taliaferro and Huck (*15*) suggested that a single dominant gene was involved, but the distinction between sicklemia and sickle cell anemia was not clearly understood at the time. The literature contains conflicting statements concerning the nature of the genetic mechanisms involved, but recently Neel (*8*) has reported an investigation which strongly indicates that the gene responsible for the sickling characteristic is in heterozygous condition in individuals with sicklemia, and homozygous in those with sickle cell anemia.

Our results had caused us to draw this inference before Neel's paper was published. The existence of normal hemoglobin and sickle cell anemia hemoglobin in roughly equal proportions in sicklemia hemoglobin preparations is obviously in complete accord with this hypothesis. In fact, if the mechanism proposed above to account for the sickling process is correct, we can identify the gene responsible for the sickling process with one of an alternative pair of alleles capable through some series of reactions of introducing the modification into the hemoglobin molecule that distinguishes sickle cell anemia hemoglobin from the normal protein.

The results of our investigation are compatible with a direct quantitative effect of this gene pair; in the chromosomes of a single nucleus of a normal adult somatic cell there is a complete absence of the sickle cell gene, while two doses of its allele are present; in the sicklemia somatic cell there exists one dose of each allele; and in the sickle cell anemia somatic cell there are two doses of the sickle cell gene, and a complete absence of its normal allele. Correspondingly, the erythrocytes of these individuals contain 100 percent normal hemoglobin, 40 percent sickle cell anemia hemoglobin and 60 percent normal hemoglobin, and 100 percent sickle cell anemia hemoglobin, respectively. This investigation reveals, therefore, a clear case of a change produced in a protein molecule by an allelic change in a single gene involved in synthesis.

The fact that sicklemia erythrocytes contain the two hemoglobins in the ratio 40:60 rather than 50:50 might be accounted for by a number of hypothetical schemes. For example, the two genes might compete for a common substrate in the synthesis of two different enzymes essential to the production of the two different hemoglobins. In this reaction, the sickle cell gene would be less efficient than its normal allele. Or, competition for a common substrate might occur at some later stage in the series of reactions leading to the synthesis of the two hemoglobins. Mechanisms of this sort are discussed in more elaborate detail by Stern (*13*).

The results obtained in the present study suggest that the erythrocytes of other hereditary hemolytic anemias be examined for the presence of abnormal hemoglobins. This we propose to do.

Based on a paper presented at the meeting of the National Academy of Sciences in Washington, D. C., in April, 1949, and at the meeting of the American Society of Biological Chemists in Detroit in April, 1949.

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The American Philosophical Society

Abstracts of Papers Presented at the 1949 Autumn Meeting, Philadelphia, Pennsylvania

Historical Botanical Collections of the American Philosophical Society and the Academy of Natural Sciences of Philadelphia

Francis W. Pennell,

Academy of Natural Sciences, Philadelphia

The Academy of Natural Sciences of Philadelphia is the depository of the largest series of early botanical collections preserved in the New World. These are plants gathered either in the latter half of the 18th or the first third of the 19th century, and they belong in equal degree to the Academy itself and to the American Philosophical Society, which deposited its collections with the Academy in 1897. Leading series are those from Francis Masson, who was in South Africa with Thunberg from 1786 to 1795 (ANSP); from Antoine Poiteau, in Haiti from 1796 to 1800 (ANSP); from Henry Muhlenberg, assembler from about 1780 to 1815 of the largest early herbarium in our country (APS); from Benjamin Smith Barton, at University of Pennsylvania from 1789 to his death in 1815, with collections made by John Wood in Australia in 1788, by Frederick Pursh in Virginia and elsewhere in 1806 and 1807, and by Meriwether Lewis on the Lewis and Clark Expedition from 1805 to 1807 (APS, but Pursh, Lewis, and other collections studied by Pursh in England are in part at ANSP); from Thomas Nuttall, over most of the United States and westward from 1807 to 1840 (ANSP, but earliest in APS); from William Baldwin in Georgia and Florida in 1815 to 1818 (ANSP and APS); and from Lewis David von Schweinitz, who was in the eastern United States from 1812 to 1834, and who made the earliest great American collection of Fungi (ANSP). These collections antedate by many years the building of great herbaria elsewhere in this country. One wonders why, after such a brilliant beginning, taxonomic investigation (other than that incidental to the amassing of personal herbaria) should have all but disappeared from Philadelphia by the middle of the 19th century.

Some Approaches to the Study of the Metal Requirements of Microorganisms

S. H. Hutner, *Haskins Laboratories*

Knowledge of the inorganic requirements for life, conveniently studied in microorganisms, lags behind that of organic nutrition. The discovery that Vitamin B_{12} (the antipernicious anemia factor) contains cobalt has stimulated interest in the identification of the trace elements required for life and their role in metabolism. Such studies are limited or impracticable until deficiency states for these elements can be induced artificially. The case of Vitamin B_{12} illustrates these difficulties. The algal flagellate *Euglena gracilis* requires Vitamin B_{12}, and it is calculated that formation of one organism requires about 4,800 molecules of B_{12}, or 4,800 atoms of cobalt.

On the assumption that the total cobalt required by the organism is contained in B_{12}, it is calculated that the known cobalt contamination (0.001%) of the iron added to the culture medium furnishes cobalt in at least a 33-fold excess. Iron itself is a relatively minor ingredient of the culture medium.

The hemoflagellate *Herpetomonas culicidarum*, which requires hemin as a growth factor, poses an analogous problem: Does the iron found in hemin represent its total iron requirement? As the iron requirement for aerobic forms is far greater than the cobalt requirement, it would seem good strategy to study first the hemin-iron relation in *Herpetomonas* before going on to the more difficult B_{12}-cobalt problem. The methods developed for solving these problems should prove applicable to identifying additional essential elements of the transitional series, should such elements be required.

The fundamental interest of such studies is underlined by the fact that vitamin B_{12} is concerned with the synthesis of desoxyribosenucleic acid, a substance bearing an intimate relation to the gene.

Varieties of Economic Law and Their Limiting Factors

John M. Clark, ***Columbia University***

The material of economics, whether we like it or not, is largely indeterminate. Normal spending responds to changing income; but total normal spending (including capital outlay) may temporarily vary more than an income does, making income unstable and indeterminate. Bargaining units have much latitude, making prices and wages indeterminate, and bargaining practices evolve. Individual economic choices, besides being indeterminate, deal with ultimate and incommensurable human values.

Economists used to tell politicians what must happen under "economic law," despite political efforts to interfere. Now it seems more nearly true that politicians decide what is to happen, leaving economists speculating as to consequences, and whether or not actual policy is fatally unsound.

I have three suggestions for making analysis more nearly realistic. First, that we deal frankly with the specific content of human values—for example, health—instead of with abstract curves of choice in theoretical markets. Second, that wherever analysis deals with the kind of relations expressed in lines on graphs—for example, demand curves or cost curves—we turn the lines into zones or bands with width representing the degree of indeterminateness that exists. Then a maximum point or a point of intersection might become a wide range, within which the actual outcome would be decided by other factors than those expressed in the curves. This should enforce active study of these other factors, usually neglected. Third, that economics should frankly investigate what is sound, by standards which it should define—for example, "What should a wise government do about consumers' freedom of choice and why?" Any reasonable answer to this would by-pass existing theories built on refining inferences from utility curves or indifference curves.

This kind of analysis should produce, not fictitiously accurate results, but hypotheses calling for verification, thus bringing deductive thinking and inductive verification closer together.

Day Book of an Education: William Shippen's Student Days in London (1759–60) and His Subsequent Career

Betsy C. Corner, ***Baltimore, Maryland***

Details about William Shippen, Jr.'s medical education had been entirely lacking until the discovery of a little diary he kept while a student in London (1759–60) was made unexpectedly some years ago by J. Hall Pleasants, of Baltimore, in whose safekeeping this 18th century manuscript has ever since remained. Through his courtesy and generosity, this little diary has recently become available for study.

In 1759 William Shippen, Jr. was enrolled at St. Thomas's Hospital, London, as a student in surgery. He also attended special lectures in midwifery, and he profited especially from intensive study of anatomy in the anatomical school established by John and William Hunter, two remarkable investigators of great importance in the history of medicine.

Shippen later studied in Edinburgh for a year and received his M.D. from the University of Edinburgh in 1761. He returned to Philadelphia in 1762 and almost immediately began to give a course in anatomy modeled upon the instruction he had received in London. To his credit, he transplanted from English to American soil not only the technical methods he had learned from the Hunters in their anatomical school, but the spirit of their experimental approach to the problems of human structure and of childbearing which were their special consideration.

Dr. Shippen's introductory lecture to his course on anatomy, given on November 11, 1762 at the State House in Philadelphia, marked the beginning of medical instruction of academic standard in the American colonies, and it set the pace for the future development of medical education in this country. Shippen also established the first classes for instruction in obstetrics, open to both sexes, in this country and started a small hospital for the lying-in care of poor women and the instruction of students in obstetrical procedure. That same year, 1765, he received his appointment as professor of anatomy and surgery in the medical department of the College of Philadelphia, the second medical professorship created by the trustees. His connection with the medical school was continuous until 1808 and for a longer time than that of any other member of the faculty of that period. Dr. Shippen is of special interest to the American Philosophical Society because he was elected to its membership in November 1767—182 years ago.

"Inanna's Descent to the Nether World": A New Tablet

Samuel Noah Kramer, *University of Pennsylvania*

Some eight years ago, in the spring of 1941, the writer read before the American Philosophical Society the then available text of the Sumerian myth "Inanna's Descent to the Nether World." It had been pieced together in the course of several years from thirteen clay tablets and fragments located in the Istanbul Museum of the Ancient Orient and in the University Museum of the University of Pennsylvania. The poem, the writer then pointed out, was still unfortunately incomplete, and he concluded his reading with the hope that sooner or later some of the missing portions would be uncovered. The present paper reports the first and partial realization of this hope; a tablet belonging to the myth has turned up in the Yale Babylonian Collection at New Haven.

It contains 92 lines of text, and its latter half carries on the story of the goddess Inanna's resurrection and return to the earth from the point where the texts had previously broken off. Moreover this new material has a rather unexpected significance; it clears up a misconception concerning the Sumerian fertility god Dumuzi—the Biblical Tammuz—which has misled students of Mesopotamian religion for more than half a century. The tablet has been carefully copied by Ferris Stephens, curator of the Yale Babylonian Collection, and has been tentatively translated by the present writer. This paper and the resulting final publication will thus represent a cooperative effort of Yale University and the University of Pennsylvania.

The Physical Distinctions of Man

Adolph H. Schultz, *Johns Hopkins University*

The physical distinctions of man are numerous and striking, if adult man is contrasted with other Primates at the completion of their growth. Early in life, man and other Primates are indistinct. Nearly all apparently fundamental, qualitative differences between adult man and apes are in reality of a mere quantitative nature, emerging gradually with age in consequence of diverging trends of development or of differing intensities in otherwise closely corresponding growth changes. The evolutionary modifications in the development of man include many accelerations as well as retardations which, though seemingly inconsequential, lead to marked peculiarities at the completion of growth.

The list of human distinctions is being constantly revised on the basis of accumulating information regarding the growth processes among Primates and can be newly evaluated by means of comparisons between the specific characters of man and those acquired by the manlike apes. In many bodily features man has remained conservative, not having changed as extremely as some other Primates. The most evident human distinctions are directly correlated with the early adaptations to the erect posture and the later enlargement of the brain. Other significant distinctions of man are connected with his latest evolutionary specializations: the prolongation in the main periods of life and the accompanying alterations in the duration and sequence of various developmental processes. Most characters, claimed as specific for man, do not represent radical innovations, but are merely the result of general evolutionary trends which have also produced very similar, though not as far-reaching, transformations in some or all of the anthropoid apes.

Characters which differ in man and the simian Primates in their average formation are often not truly distinctive, if individual conditions are taken into consideration, since the ranges of variations in many features are surprisingly extensive and can overlap in man and one or another of the anthropoids.

Generally speaking, man is clearly and constantly distinguished from all other Primates by his peculiar *combination* of characters which, singly, are often distinct only in regard to the degree of their specialization or the relative frequency of their occurrence.

These generalizations will be illustrated by discussions of examples of physical features distinctive of man.

The Chemical Combination of Insulin with Muscle and Its Hormonal Regulation

William C. Stadie, *University of Pennsylvania*

Understanding of the fundamental problems of diabetes must await more complete knowledge than is available now of the chemical or physical mechanisms by which insulin affects the metabolism of mammalian tissues. The most prominent conception is that insulin affects one or more of the tissue enzymes which catalyze the multiple reactions concerned in the metabolism of fat, protein, or carbohydrate. Cell-free enzyme systems prepared from normal or pathological tissues should be ideal for the demonstration of such effects, but few demonstrations of insulin effects on such cell-free systems have been reported and these have been difficult to reproduce.

In sharp contrast, the effects of insulin upon intact cells, either *in vitro* or *in vivo*, have been unequivocally demonstrated by many workers. It is conceivable, then, that intact cellular morphology is a necessary condition for the action of the hormone. In that case, physical effects, such as on permeability, rather than chemical effects on enzymes, must be considered as possible effects of insulin. Irrespective of the precise mode of action, it is highly presumptive that, once having entered the cell, insulin must attach itself to some morphological element. This initial direct combination of insulin with the intact cell might indeed be the initial obligatory reaction required for metabolic activity of the hormone. We[1] have succeeded in demonstrating for the first time that such a chemical reaction occurs.

The demonstration is accomplished in the following way: a hemidiaphragm from a normal rat is equilibrated for one minute or less in a medium containing a small concentration of insulin. During this brief exposure to insulin firm combination has occurred with some constituent of the muscle cell, and the combined insulin alters the metabolic pattern of the muscle. This is shown by the fact that invariably the insulinized hemidiaphragm, when equilibrated in a glucose-containing medium, utilizes more glucose and synthesizes more glycogen than an appropriate control.

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[1] The experimental data discussed here are taken from a paper by W. C. Stadie, N. Haugaard, J. B. Marsh, and A. G. Hills. *Amer. J. med. Sci.*, Sept., 1949.

This phenomenon has been studied in the normal rat under a variety of conditions, and in rats with endocrine abnormalities, or those injected with various hormonal preparations. The results indicate that chemical combination of insulin with muscle is under hormonal control and appears to be an important factor in the regulatory mechanism of carbohydrate metabolism in the normal and diabetic animal.

The Development of Contractility

John S. Nicholas, ***Yale University***

The origin of contractility must naturally be a function of the developing embryonic tissue and in many organisms is initially common to many different kinds of tissue. In higher forms, however, the contractile nature of protoplasm is largely localized in muscle tissue, and the other tissues lose whatever contractile powers they may have possessed.

In the rat embryo, muscular movement is first noticed after 15 days of development and the flexions and rotations of the body of the fetus attain a considerable complexity before birth. During this period, as well as in the period before movement, the mesoderm has given rise through differentiation to muscle tissue markedly different from adult tissue, consisting of a loose arrangement free of fibers and with no discrete structures such as those normally described for muscle.

In the past few years there has been a tremendous advance in the study of the chemical nature of muscle and it was decided to investigate the chemical, physical, and morphological character of developing muscle, in order thereby to attain critical information which might be correlated with the contractile process.

The most pertinent studies are those which deal with the liberation of inorganic phosphate in chemically separated fractions of developing muscle at different stages of its differentiation, and the correlation of this activity with the nucleic acid content, the development of the muscle respiratory enzymes, and the appearance of birefringence in the developing muscle.

When embryonic muscle is fractionated, the activity of each fraction develops independently and at different rates. This general finding is similar to that of Shen and Boell on the development of the respiratory enzymes in developing muscle. Apparently definite contribution to the chemistry of contractile tissues is made independently by the separable substances. The development of birefringence pattern antedates the formation of actual contractile tissue by a considerable period—at least 12 hours—and occurs at least 24 hours before the first embryonic striations can be observed. The correlation of these and other factors throws considerable light upon the mechanism of beginning contraction.

Studies on the Development of the Cortex of the Brain

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The aim of these investigations has been to establish how long before birth evidence of function can be found in the nerve cells of the cerebral cortex of the guinea pig and how functional development of these cells is related to their structural and chemical development. On microscopic examination, a series of abrupt changes was observed to occur in the nerve cells two-thirds of the way through gestation. Nerve processes start to grow rapidly, nucleoprotein appears in large quantity in the cytoplasm, and the nucleus ceases to increase in volume. These structural developments are accompanied by several changes. The enzyme, adenylpyrophosphatase, believed by its activity to yield useful energy to the cell, increases sharply in activity to the adult level. The activities of the respiratory enzymes, succinic dehydrogenase, and cytochrome C, responsible in part for the combustion of foodstuffs, also increase rapidly to the adult level. At the same period the nerve cells for the first time are electrically active; electrical potential changes can be recorded from the surface of the brain. These potential changes were demonstrated to arise from the cortex itself by local application of strychnine, which produces typical increase in electrical activity. The onset of this cortical electrical activity appears to be causally related to a sudden increase in the permeability of the nerve cells to sodium. This observation fits the hypothesis, advanced by others, that the potential change which follows the stimulation of peripheral nerve is due to the momentary appearance of a selective permeability to sodium.

It is concluded that the nerve cells of the cerebral cortex of the guinea pig begin to show functional activity about two-thirds of the way through gestation and that structural, chemical, and functional differentiation of these cells occurs at the same time or in rapid succession.

Redwoods—Occidental and Oriental

Ralph W. Chaney, ***University of California***[2]

The recently discovered redwood of Asia, *Metasequoia glyptostroboides*, shows relationship to the redwood of North America, *Sequoia sempervirens*, and to the swamp cypress, *Taxodium distichum*. Foliage and cones of the living trees provide characters by which they may be readily distinguished, but for nearly a century there has been confusion in the recognition of fossil specimens.

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[2] Research associate, Carnegie Institution of Washington.

Large collections from the Cretaceous and Tertiary deposits of western North America have recently been restudied; criteria have been established for separating fossils of the three genera, and for setting up recognizable species.

During Cretaceous time, and at the beginning of the Tertiary period, *Metasequoia* was abundant at high northern latitudes. Its deciduous habit was well suited to a regime of summer rainfall and lowered winter temperature. With gradual reduction in rainfall and temperature, *Metasequoia* and its associates are recorded from successively more southerly stations, as far south as California; near the end of the Tertiary period it became extinct in North America, probably as a result of a shift to winter rainfall and summer drought. Its failure to survive in the southeastern United States along with *Taxodium*, which is also deciduous, cannot now be explained.

The geologic history of *Sequoia* has been somewhat different because of its evergreen habit. Never as abundant as *Metasequoia*, the ancestors of the California redwood were in past ages largely limited to foothills and to the borders of ancient seas. With the change in rainfall regime during later Tertiary time, *Sequoia* was restricted to the borders of the Pacific; in regions with summer fog it still survives. *Metasequoia* is known to exist only in the interior of China, where heavy summer rainfall is combined with moderate temperatures. Here in valleys so remote that they have not yet been completely deforested by land-hungry farmers, the redwood of Asia appears to be living the last chapter of its hundred million-year existence.

TECHNICAL PAPERS

Mutual Interaction of Polyelectrolytes[1]

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Polyelectrolytes (*1*), even in the most dilute solution, give regions of high charge density in the neighborhood of each polyion, as a simple consequence of structure. We might therefore expect a strong electrostatic interaction between the fields of polycations and polyanions, which would lead to mutual precipitation. Results are herewith presented which verify this prediction.

In one series of experiments, portions of a dilute solution of sodium polyacrylate[3] were added to a solution of poly-4-vinyl-*n*-*N*-butylpyridonium bromide. Flocculent precipitates formed immediately; at concentrations as low as 10^{-6} normal in bromide ion (about 10^{-8} molar in polyelectrolyte), a distinct turbidity was still visible. The precipitation was followed quantitatively by measuring the turbidity of the mixtures with a Phoenix light-scattering photometer. Fig. 1 shows the results of a typical experiment in which successive portions of 10^{-6} normal polyacrylate solution were added to 40 ml of 25×10^{-6} normal polypyridonium bromide. Up to the equivalence point, the turbidity τ increased linearly with the amount of polyacrylate added; just beyond equivalence, the turbidity increase accelerated sharply, and after a ratio of about 1.5, slowly decreased with further addition of polyacrylate. Fig. 2 is a log-log plot of the turbidity obtained when 1.5 equivalents of polyacrylate were added to 1.0 equivalent of polypyridonium salt, the latter at varying stoichiometric bromide concentrations, N. It will be noted that the points fall on a 45° line, showing that the amount of precipitate is proportional to the concentration of the polypyridonium solution from which it was precipitated down to below millionth normal in bromide ion (approximately 10^{-9} molar in polybromide or 0.2 ppm by weight). The lowest concentration corresponds to the present limit of sensitivity of our optical equipment.

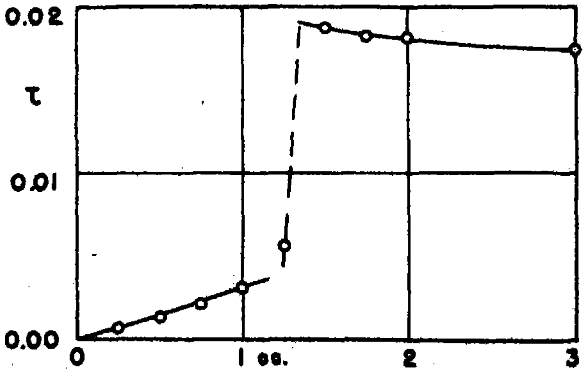

FIG. 1. Turbidimetric titration of polyvinyl-butyl-pyridonium bromide (40 cc of 25×10^{-6} normal) with sodium polyacrylate (10^{-6} normal).

These results may be interpreted as follows: When polyacrylate is added to polypyridonium salt, the latter is initially in excess. Normally, each polyacrylate ion is surrounded by an atmosphere of sodium counter ions; when a polyacrylate ion-plus-ion cloud encounters polypyridonium ions, the strong attractive field between poly-

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[1] Project NR 054–002 of the Office of Naval Research.

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[3] We are grateful to the Minnesota Mining and Manufacturing Company for a sample of polyacrylic acid and to the Dow Chemical Company for a sample of sodium polystyrene sulfonate.

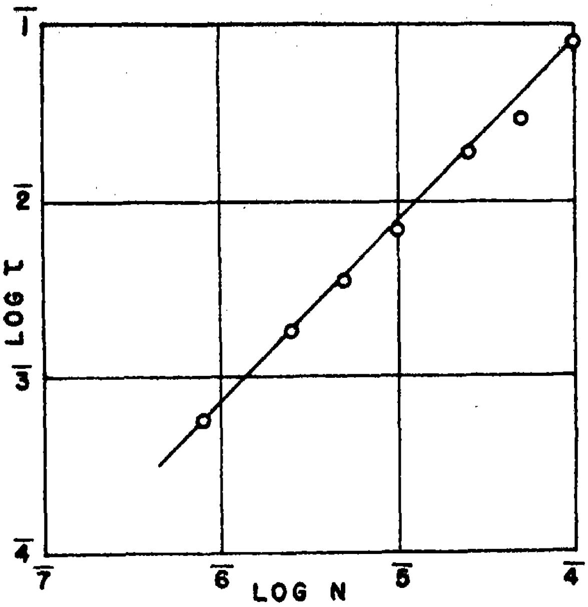

FIG. 2. Test of proportionality between turbidity and concentration of polyelectrolyte solution.

anion and polycations causes the polymeric ions to approach, and many of the monovalent gegen ions are displaced. The resulting aggregate is a compact insoluble cluster, cross-linked by electrostatic forces. We naturally do not expect perfect pairing of acrylate and pyridonium ions; those unpaired will be accompanied by their corresponding gegen ions. Since the pyridonium salt is in the medium into which the acrylate is poured and is initially in excess, the exterior of the cluster will be mostly polypyridonium chains. Then when excess acrylate is added, more polyanions attach themselves to the polycationic exterior of the precipitate particles, displacing both sodium and bromide counter ions until the excess charge is compensated. This hypothesis accounts for the sharp rise in turbidity just beyond the equivalence point followed by a leveling off at a fairly well-defined degree of excess. The subsequent slow decrease of turbidity probably is due to an electrostatic contraction of the particles of precipitate in the presence of excess ions, or else to coalescence of original particles. We plan to determine particle size.

In another series of experiments, solutions of sodium polystyrene sulfonate were mixed with polypyridonium bromide solutions. Again, flocculent precipitates formed. These experiments were carried out at higher concentrations of polyelectrolytes, so that conventional analytical methods could be used. The precipitates were centrifuged out, dried and weighed, and bromide ion in the supernatant liquid was determined by potentiometric titration. The results of a typical series of experiments are given in Table 1, where the polybromide solution (B) analyzed to 0.0180 normal in bromide ion. The concentration (approximately 0.005 normal in sulfonate) of the polysulfonate solution (S) was not accurately known, because the starting material contained some insoluble cross-linked products which were removed by centrifuging before the solution was used. (There also appeared to be some impurity of low molecular weight present.) In all the experiments of Table 1, polybromide was in excess. The first column gives the volume and sequence of reagents; e.g., "5 B: 20 S" means that 5 cc of polybromide was poured into 20 cc of polysulfonate. The second column gives the weight (in mg) of precipitate found, and the third, the mg of precipitate per unit volume of polysulfonate solution. The fourth column gives the number of milliequivalents of bromide ion used, and the fifth, the deficiency of bromide ion in the supernatant liquid after mixing with polysulfonate and centrifuging out the precipitate. This deficiency corresponds to bromide ions which accompanied the precipitate as neutralizing counter ions for the dangling polypyridonium chains.

An average of 1.58 mg/cc precipitate was obtained when polysulfonate was poured into polypyridonium salt. Here the polycation was always in excess, so each polyanion formed the nucleus for a precipitate particle which contained more than a stoichiometric equivalent of polypyridonium, due to its dangling chain ends. When polybromide was poured into polysulfonate, however, an average of 2.17 mg/cc sulfonate solution was found. This result seems reasonable on the basis of our picture of the mechanism of precipitation; at first, polyanions were in excess, and each polycation added was the nucleus for a precipitate particle which contained dangling polyacrylate chains. Further addition of polycation added to the polyanionic chain ends, thereby increasing the weight of the precipitate which had formed initially. As seen in Table 1, the bromide ion deficiency was correspondingly greater for this sequence of mixing.

These precipitates are inherently different, both from familiar electrolytic precipitates like silver chloride and from the colloidal coagulates, such as those obtained from mixing suspensions of arsenious sulfide and of ferric hydroxide. In all three cases, electrostatic forces cause the approach of particles of opposite charge; with silver chloride, a substance of low intrinsic solubility is formed from silver ion and chloride ion, while with the colloidal precipitates, rigid, relatively massive particles coalesce. But with the polyelectrolytes, the individual charges are normal in their behavior; it is their high local concentration which brings about expulsion of gegen ions and solvent, and leads to precipitation. (Both sodium acetate and sodium benzene sulfonate, for example, will precipitate the polypyridine salt only at very high concentrations.)

TABLE 1

PRECIPITATION OF POLYVINYL-BUTYL-PYRIDONIUM BROMIDE WITH SODIUM POLYSTYRENE SULFONATE

Expt.	Ppt. in mg	mg/cc	Meq. Br^-	ΔBr^-
5 B : 20 S	47.9	2.40	0.090	0.0090
10 B : 20 S	40.1	2.00	0.180	0.0151
10 B : 10 S	21.6	2.16	0.180	0.0163
20 B : 10 S	21.2	2.12	0.360	0.0184
20 S : 5 B	37.0	1.85	0.090	0.0081
20 S : 10 B	25.9	1.30	0.180	0.0111
10 S : 10 B	14.9	1.49	0.180	0.0125
10 S : 20 B	16.8	1.68	0.360	0.0168

When the charge density is as high as that corresponding to vinyl polymers such as we used (where an ionogenic group is attached to every second carbon atom of the chain), we would expect that any polycation will precipitate any polyanion. On the other hand, by preparing copolymers (*2*) with controlled spacing of charges, it might be possible to obtain polyelectrolytes which show a selective precipitability, according to whether opposite charges can be paired off geometrically or not. It might thus be possible to make a model similar to those postulated (*4*) for immunological reagents.

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Is Chloride a Coenzyme of Photosynthesis?

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One of the serious obstacles in the experimental study of the mechanism of photosynthesis has been the impossibility of separating the process from the activities of intact green cells. The recent work of Hill (*5*) makes it possible, however, to investigate outside the living cell the reaction most characteristic of photosynthesis in green leaves: photolysis of water resulting in the evolution of gaseous oxygen. The oxygen-liberating system resides in the chloroplasts, and remains functional when fragments or whole chloroplasts are removed from green leaves.

The photochemical evolution of oxygen by chloroplasts isolated from sugar beet and spinach was recently investigated by Warburg and Lüttgens (*6*), who reached the rather striking conclusion that chloride ion was a coenzyme essential for photochemical reactions in photosynthesis. That such a simple yet important fact had escaped the notice of all other workers in this field was indeed cause enough for Warburg and Lüttgens to remark how rash were all previous theories on the mechanism of photosynthesis. The evidence which led these authors to conclude that chloride is a coenzyme of photosynthesis was as follows. Isolated chloroplasts lose their capacity for oxygen evolution after several washings in water. They can be reactivated, however, by adding cytoplasmic fluid. The factor in cytoplasmic fluid responsible for reactivation of the chloroplast was found to be heat-stable. An analysis disclosed that cytoplasmic fluid contained chloride in 0.08 molar concentration. Addition of chloride alone as M/150 KCl brought about complete reactivation. Of the other anions tried, bromide was almost as effective, iodide and nitrate much less so, and fluoride, sulfate, thiocyanate, phosphate, and all the cations tried were without effect. Since chloride was the effective anion found in sufficient concentration in cytoplasmic fluid, Warburg and Lüttgens concluded that it was the natural coenzyme of photosynthesis.

Impressive as this chain of biochemical evidence is in support of chloride as a coenzyme of photosynthesis, it poses at once a rather perplexing physiological problem from the standpoint of plant nutrition. Chloride is not generally regarded as an essential element for growth of higher plants. Is it then possible that plants can get along in nutrient solutions without a coenzyme required for photosynthesis, a process indispensable for growth? The fact that Warburg and Lüttgens found appreciable amounts of chloride in their plants is not surprising. Chloride is widely distributed in soils and readily absorbed by most plants. Its presence in the plant, however, was hitherto regarded as incidental.

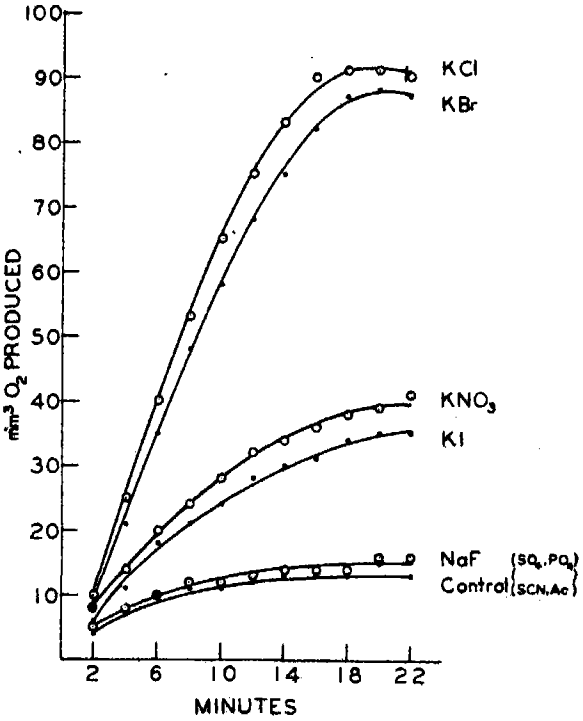

FIG. 1. Effect of anions (10^{-3} M) on oxygen evolution by illuminated chard chloroplasts. Reaction mixture: A chloroplast suspension containing 0.5 mg of chlorophyll, M/15 phosphate buffer, quinone as oxidant. Illumination at flask level approx. 28,000 lux, temp = 15° C. Other details of technique were similar to those previously described (*4*).

We undertook to investigate the problem by growing sugar beet and chard in nutrient solutions without chloride. Plants were grown in a nutrient solution supplemented with the micronutrients B, Mn, Cu, Zn, and Mo in amounts and from sources previously described (*1*), except that $MnSO_4$ was substituted for $MnCl_2$. As was expected, the plants made excellent growth in the nutrient solution to which no chloride was added. The chloroplasts from these plants were isolated (*2*) and their oxygen evolution under the influence of light was measured manometrically, by a technique similar to that used by Warburg and Lüttgens (*4*).

Our results disclosed important areas of agreement with those of Warburg and Lüttgens, as well as several differences. An analysis of both chloroplasts and cytoplasmic fluid showed no chloride in either, as would be expected in plants grown without chloride. Chloroplasts, even without washing, showed only feeble oxygen evolution. In our experiments, in contrast to those of Warburg and Lüttgens, the addition of cytoplasmic fluid failed to reactivate the chloroplasts, but as already noted, our cytoplasmic fluid contained no chloride. On the other hand, we fully substantiated the finding of Warburg and Lüttgens that addition of chloride brought about activation of chloroplasts, giving us stoichiometric yields of oxygen in relation to the oxidant used. The effect of chloride on the course of oxygen evolution by illuminated chloroplasts is shown in Fig. 1, which also confirms the findings of these authors with regard to the influence of other anions on oxygen evolution. Bromide has an activating effect about equal to chloride; nitrate and iodide are much less effective; and sulfate, phosphate, thiocyanate, and acetate are without effect.

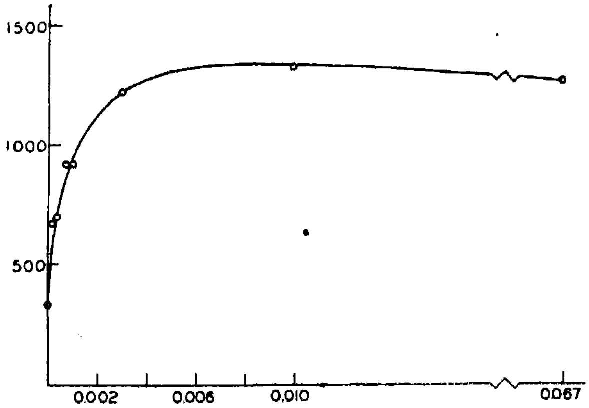

FIG. 2. Abscissas: KCl concentration. Ordinates: $Q_{O_2}^{chl}$. Effect of KCl concentration on rate of oxygen evolution by illuminated chloroplast fragments. $Q_{O_2}^{chl}$ = mm³ of oxygen/hr /mg of chlorophyll, computed from data obtained for the 6-min period from 1 to 7 min after turning on the light. Temp = 20° C. Conditions not specified were similar to those given in the legend for Fig. 1.

How should these results be interpreted? The intact plant is able to carry on normal photosynthesis without chloride, as judged by its excellent growth despite absence of this ion either in nutrient medium or in leaf tissue. Yet when chloroplasts are isolated from the same plant, they require chloride for vigorous progress of the photochemical reaction. One explanation would be that chloride acts in the leaf as a micronutrient, and that minute amounts of chloride which escape detection by usual chemical analysis may nevertheless be present in the nutrient medium as an impurity and reach the leaf. This explanation, although it cannot be ruled out entirely, is rendered unlikely by the data presented in Fig. 2. In this chart, the rate of oxygen evolution by illuminated chloroplasts ($Q_{O_2}^{chl}$) is plotted against chloride concentration. It will be seen that, whereas small additions of chloride brought about appreciable activation, a fairly high concentration, around 0.007 M, is required for full activation. This is in agreement with the value of M/150 KCl, reported by Warburg and Lüttgens as necessary for full activation in their experiments. Such relatively high concentrations of chloride are not uncommon in soil-grown plants, but there is strong evidence from these and numerous other experiments that plants can make excellent growth without the presence of measurable amounts of chloride either in the nutrient medium or in the plant. The other anion capable of giving full activation of photochemical oxygen evolution, bromide, although readily absorbed and tolerated by plants in appreciable amounts, is not a common constituent of plants or soils, and there is even less reason for suspecting it as being essential for plant growth.

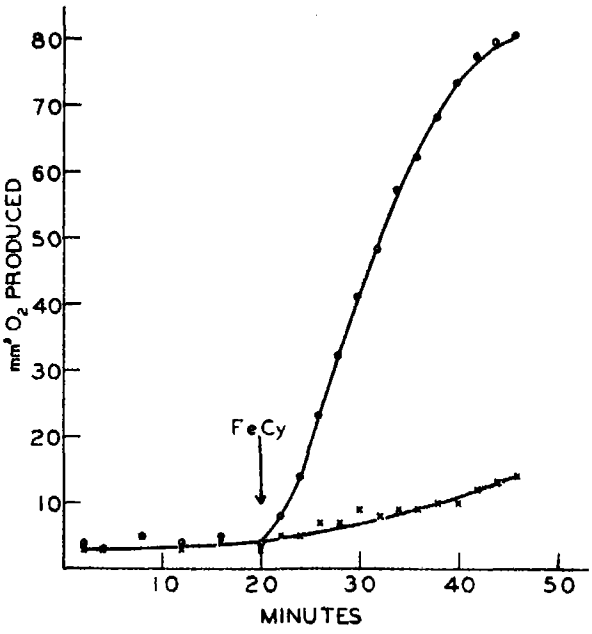

FIG. 3. Protective effect of chloride on illuminated sugar beet chloroplast fragments. *Circles*—illuminated for 20 min in the presence of chloride. At *t* = 20 min, the oxidant (ferricyanide) was tipped into the manometer vessel. *Crosses*—illuminated for 20 min in the absence of chloride. At *t* = 20 min, chloride and ferricyanide were added simultaneously. The concentration of chloride was 0.01 M KCl. A quantity of 1.5×10^{-7} moles of $K_3Fe(CN)_6$ was added to each vessel. Conditions not specified were the same as those given in legend for Fig. 1.

If the view that chloride or bromide is a coenzyme of photosynthesis *in vivo* is to be abandoned, how can the effect of these anions *in vitro* be explained? We have formulated the hypothesis that in the intact green cell photosynthesis goes on without participation of either chloride or bromide, but once the cell is broken there is a rapid light-induced deterioration of some cellular substance essential for the photochemical evolution of oxygen by chloroplasts. Chloride or bromide is able to protect this substance against inactivation, but the intact cell accomplishes this in some other manner. This would explain the superfluousness of the halide *in vivo* as contrasted with its requirement *in vitro*.

The hypothesis was tested in the following manner. Isolated chloroplast fragments were illuminated without, however, adding the oxidant (in this case ferricyanide) which is necessary to bring about the evolution of oxygen. In one instance, chloride was added to the illuminated chloroplasts; the control contained no chloride. After 20 min of preexposure to light, the oxidant was added and the photochemical oxygen evolution was measured manometrically. To the chloroplast suspension which was exposed to light in the absence of chloride, this anion was added simultaneously with the oxidant. The results are shown in Fig. 3. The preexposure to light in the absence of chloride inactivated the oxygen evolution system of the chloroplasts. This inactivation was nearly irreversible. The subsequent addition of chloride had only a slight reactivating effect. On the other hand, a vigorous oxygen evolution, resulting in stoichiometric yields, was given by the chloroplasts which had received added chloride during their exposure to light. Thus chloride appeared to protect some essential photosynthetic substance which in the absence of this anion was irreversibly destroyed by light. Chloride also seemed to exert some protective action on the chloroplasts in the dark. There was evidence of inactivation from shaking chloroplasts in the manometer vessels at 15° C, for a period equal to the light exposure. Inactivation in light, however, was much more pronounced. The identification of this substance would be of great physiological interest. Experiments along this line have been under way in our laboratory, but no conclusion is possible at this time.

The proposal that chloride is a coenzyme of photosynthesis would have endowed chlorine with the status of an essential element for growth of higher plants. It would also have been the first instance in the history of plant nutrition where the essentiality of an inorganic element was established by the discovery of its biochemical function, in the absence of corroborative evidence from growth experiments according to specific criteria of indispensability (*3*). Our results, which speak against the role of chloride as a coenzyme in photosynthesis, also illustrate the contribution which growth experiments can make in evaluation of biochemical data bearing on the essential status of an inorganic element in nutrition of higher plants.

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The Action of Mineral-Ion Exchange Resins on Certain Milk Constituents

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With the discovery in 1936 by Adams and Holmes (*1*) that certain artificial resinous materials possess the ability to act as ion exchangers, new interest was aroused in this field. A large number of such synthetic ion-exchange materials are now commercially available, and various laboratories have been experimenting with their properties when used to treat milk. It was felt that some fundamental studies should be made also on the action of typical anion-exchanger and cation-exchanger resins with simple solutions of the known major inorganic milk constituents, at concentrations as they normally occur.

In 1933, Lyman and co-workers (*5*) discovered that by the action of certain natural base-exchange materials called zeolites, the mineral constituents of milk could be modified, chiefly by decrease in calcium ion, so as to im-

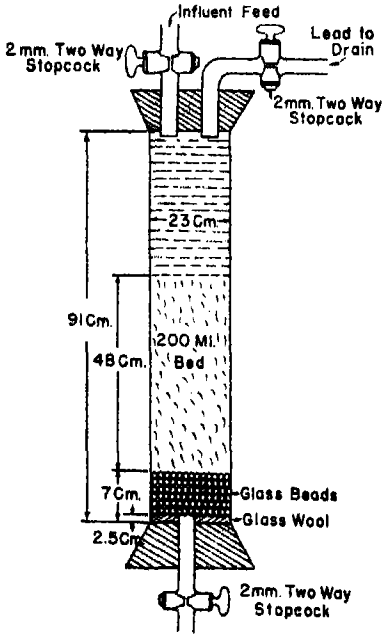

FIG. 1. Ion-exchange column. The Zeo-Karb-H column was initially conditioned with 400 ml of 5% NaCl, downflow at a rate of 13.7 ml/min, backwashed at flow rate to give 50% bed expansion for 5 min, regenerated with 450 ml of 0.407 *N* HCl at 17 ml/min, and washed with distilled H_2O at the same rate until free of acid. The De-Acidite column was exhausted with 2,000 ml of 0.100 *N* HCl, backwashed, regenerated with 280 ml of 0.75 *N* Na_2CO_3 at 4.5 ml/min, and washed free of alkali.

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prove the ease of digestion and assimilation of milk through the softer curd obtained. Other investigators (4) have found that M.I.E. (mineral-ion exchange)-treated milk added to evaporated milk was capable of stabilizing the product against coagulation during sterilization at 240° F for 15 min. The M.I.E. milk can be used as a fluid, powder, or concentrate. Burgess[3] has a patent that covers the use of an artificial ion-exchange material for removing calcium ions more or less completely from milk. Otting (6) has discussed the problems which were surmounted in the application of the mineral-ion exchange principle in milk products, and the equipment and procedure to be used.

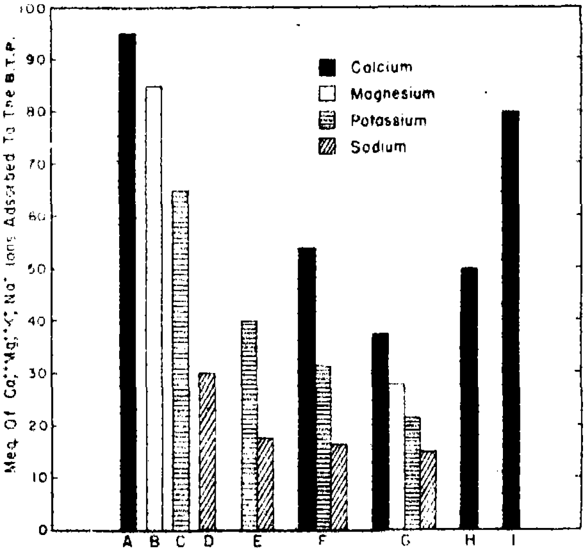

FIG. 2. Adsorption of cations to the B.T.P. by Zeo-Karb-H. Two thousand ml of the following solutions was passed through the column. *A*. $CaCl_2$, 100 meq./l; *B*. $MgCl_2$, 100 meq./l; *C*. KCl, 100 meq./l; *D*. NaCl, 100 meq./l; *E*. Binary soln. of $CaCl_2$ and NaCl, 50 meq. each/l; *F*. Ternary soln. of $CaCl_2$, KCl, and NaCl, 33.3 meq. each/l; *G*. Quaternary soln. of $CaCl_2$, $MgCl_2$, KCl, and NaCl, 25 meq. each /l; *H*. Binary soln. of $CaCl_2$ and HCl, 50 meq. each /l; *I*. Binary soln. of $CaCl_2$ and citric acid, 50 meq. each /l. Influent flow rate 50 ml/min; column regenerated with 450 ml of 0.407 *N* HCl at 17 ml/min, followed with 200 ml distilled H_2O at the same rate, then a fast rinse at 50 ml/min for 10 min.

Numerous other investigations have been made on the use of ion-exchange substances in the separation of cations from anions (*7–10*), in the separation of amino acids, purine, and pyrimidine bases, alkaloids, and many other substances (*2, 5, 11*).

The present paper describes briefly the action of a representative pair of commercial anion and cation exchange resins on the various salts known to occur in milk. The salts were prepared in water solutions containing one, two, three, or four of the cation or anion constituents found in milk, in equivalent concentrations, and then given appropriate ion-exchanger treatment.

Zeo-Karb-H and De-Acidite[4] were the exchangers employed. The columns were set up as shown in Fig. 1. The air-dry exchanger was added to the column until a 200-ml backwashed and drained volume was obtained. Before using the columns in experimental procedures, each was put through two cycles of exhaustion and regeneration in order to condition the beds.

The break-through point (B.T.P.) was designated as that point at which the concentration of a given ion in the effluent reached a value which was 5% of the initial concentration, while 95% was still being adsorbed by the exchanger. The results were expressed in terms of milliequivalents adsorbed to the B.T.P.

The increasing order of removal for the cations studied, either from individual ion solutions or from mixtures of all four, was from sodium to potassium to magnesium to calcium. The type of opposite ion present in solution was found to be a factor in some cases, since calcium ions were found to be more completely removed by the cation exchanger if the anion present was citrate, than if it was the chloride ion. This is shown in Fig. 2.

When the B.T.P. has been reached, the concentration of the ion in the effluent rapidly approaches the initial concentration, and in the solutions containing two, three, or four of the cations, it has been found that some of them may surpass their initial ion concentration.

The cations present in a complex solution that appear to be least adsorbed by the exchanger were found in reality to be removed during the first part of the exchange run, then released later by the regeneration effect of the other cations in the solution which were preferentially adsorbed. Thus, the hydrogen ion from the exchanger in the acid cycle is not always exchanged each time a cation enters the exchanger, since the entering cation may replace a previously adsorbed cation. The hydrogen ion-cation exchange for solutions containing one cation was found to be quantitative.

When single, binary, and ternary solutions of hydrochloric, citric, and phosphoric acid were passed through a bed of an anion exchanger, De-Acidite, it was found that the order of removal for acids in mixtures was different from the order in trials with solutions containing but one acid. Thus, the order of removal of the acids from individual solutions increased from hydrochloric to citric to phosphoric, but in a solution containing all three acids the order of increased removal was from citric to phosphoric to hydrochloric.

A 0.6% solution of urea, creatine, and creatinine, each being present in 0.20% concentration, was subjected to cation-exchange treatment. A 100% removal of these substances was effected from the first 400 ml of effluent. A 50% removal still occurred after 1600 ml of solution had passed through the bed. These substances were not adsorbed from solution by De-Acidite, an anion-exchange resin.

From the experimental results obtained in this study on less complicated true solutions, and from unpublished data on the action of ion-exchange resins on skim milk, whole milk, and deproteinized milk, ion-exchange materials appear to offer a variety of possibilities for modifying the mineral components of milk, either by removal of certain ions, by substituting other ions for normal ions present, or by both operations. Unpublished work, by one of the authors, E. F. Almy, on the calcium removal from cation-exchanged skim milk, shows that removals for calcium start at 83% and drop to 39% as the exchange run progresses, whereas the adsorption for phosphorus remains constant at approximately 7–8%.

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[3] Burgess Zeolite Co. Ltd. British patent, No. 542,846 (1942). C. A. 36: 4217-4.

[4] Manufactured by the Permutit Company, New York City.

Applications of ion-exchange milk to produce smoother ice cream, to improve the quality of baked goods made with milk, and to improve various other dairy products have been suggested, but await further investigation. A local company[4] has patent applications filed covering complete demineralization of cheese whey for the production of lactose with low mineral (ash) content, and for the production of the M.I.E. milk previously mentioned. It also has filed patent applications covering the production of a powdered cream which has been rendered heat-stable by ion exchange to lower the calcium ion content before drying.

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The ΔG/ΔP Ratio after the Administration of Dextrose as an Index of Insular Function

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In the course of some investigations on the decrease in serum inorganic phosphorus produced by the administration of glucose, it was found useful to relate increase in blood sugar values to decrease in inorganic phosphate.

It is well known that deficiency in insulin production is accompanied by high blood sugar levels as determined a half hour after administration of the carbohydrate, and vice versa, that increased insulin secretion leads to low values. However, there are factors, such as rate of glycogenolysis, secretion of epinephrine, storage ability of the tissues, and different rates of intestinal absorption, that may easily alter blood sugar levels.

The decrease in serum inorganic phosphorus which follows dextrose administration (*1, 5, 7*) depends upon the liberation of insulin; in fact, it does not take place in the pancreatectomized animal (*2*). Epinephrine also produces a similar decrease, but only in animals with intact pancreas (*8*). Insulin and epinephrine produce the same changes in inorganic phosphorus, insulin acting by itself (*9*), and epinephrine through the discharge of insulin induced by the elevation of blood sugar. The decrease in inorganic phosphate determined by glucose is not affected by liver deficiency (*2*).

TABLE 1

The ΔG/ΔP Ratio, in Normal and Alloxan-treated Dogs

Group	Number of animals	ΔG/ΔP Ratio averages ± standard errors
Normal dogs		
Staub effect present	26	60.4 ± 18.2
Staub effect absent	17	105.9 ± 53.5
Alloxan-treated dogs	9	316.8 ± 75.2

TABLE 2

Statistical Significance of the Differences between Means*

	p Values
Normal dogs, Staub effect present, vs. Staub effect absent	0.40
Normal dogs, Staub effect present, vs. alloxan-treated dogs	< 0.01
Normal dogs, Staub effect absent, vs. alloxan-treated dogs	0.02

* Student's test (*3*).

These facts show the importance of studying systematically changes in serum inorganic phosphorus during the glucose tolerance test, in metabolic clinics, and in research laboratories. The results of such investigations are herewith reported.

The work was carried out in apparently normal dogs and in alloxan-treated dogs. Some of the normal dogs were in poor nutritional condition. A fasting sample was taken from the saphena vein, and immediately 1 ml/kg of body weight of a 50% glucose solution injected into this vessel; 30 min later a second sample was taken and the injection of dextrose repeated; 30 min later the last sample was drawn. The blood sugar determinations were carried out in duplicate, according to the Nelson method (*6*) and the serum inorganic phosphate determinations were also done in duplicate by the Fiske-Subbarow procedure (*4*). The ΔG/ΔP ratio was calculated in the following manner: the difference between the blood sugar value at 30 min and the initial value was divided by the difference between the initial serum phosphate and its value at 30 min. Results are shown in Tables 1 and 2 and Fig. 1.

From these results some conclusions can be established.

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[1] With the technical assistance of Miss Jeanne Lopez, Miss Luisa Maria Andueza, and the cooperation of Dr. Alfonzo Podrizki.

[4] M. & R. Dietetic Laboratories, Columbus, Ohio.

The ratio ΔG/ΔP is a useful indicator of insular function, being less affected than the Staub effect by malnutrition and other factors that impair carbohydrate storage or utilization. While 39.5% of the apparently normal dogs did not have the Staub effect, only 16.2% of the animals had a ΔG/ΔP ratio smaller than -100, the assumed normal limit. All of the diabetic dogs had a ratio smaller than -100.

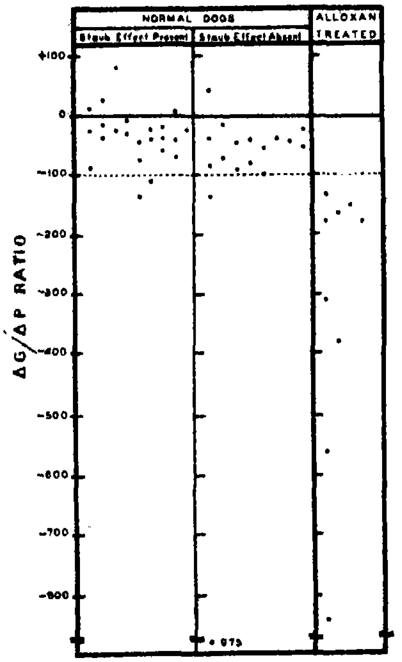

FIG. 1.

The positive values shown had a negative glucose difference, suggesting a faster rate of sugar removal from the blood. When the index is positive, because of a positive phosphorus difference, it means there is a defective production of insulin.

The results in diabetic patients and in normal human subjects will be reported elsewhere; they are in agreement with the experimental data obtained.

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Amino Acids in the Mitochondrial Fractions of Tissues as Determined by Paper Partition Chromatography

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The biochemical properties of intracellular structures identified as mitochondria have received considerable attention recently. However, little is known of the nature of the protein moiety of these important cell constituents. As a first step in the characterization of mitochondrial protein, the amino acids in acid hydrolyzates were studied by two-dimensional paper chromatography (*1, 2*).

The method used for the isolation of the mitochondria was essentially that of Hogeboom *et al.* (*3*) with the exception that additional cycles of low and high speed centrifugation were employed to insure the attainment of maximal uniformity of the sedimented material. The isolated particles were the same size and shape as the structures identified as mitochondria in smears made from homogenates, and in free cells found in the sediment from the first low speed centrifugation. These particles possessed the same staining characteristics, with Janus green B before fixation, and with aniline-acid fuchsin after fixation with osmic acid, as do mitochondria in cells. The isolated mitochondria were hydrolyzed with 6 *N* HCl in sealed tubes for 24 hr and aliquots were subjected to chromatography. Samples were treated with H_2O_2 to enable detection of cystine as cysteic acid and methionine as methionine sulfone. Numerous chromatograms were

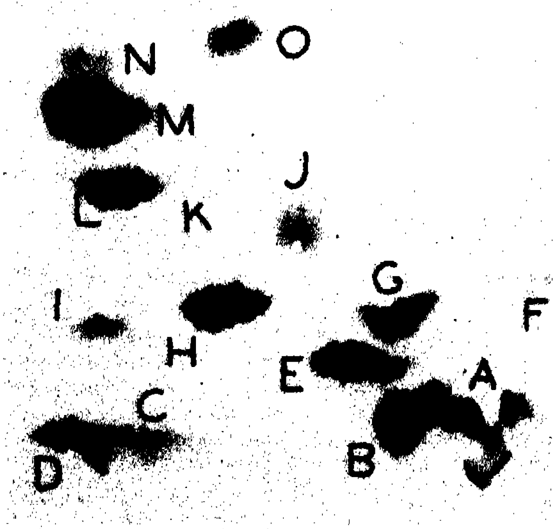

FIG. 1. Photograph of chromatogram from hydrolyzate of rat kidney mitochondria. (A) Aspartic acid, (B) glutamic acid, (C) lysine, (D) arginine, (E) glycine, (F) cystine (cysteic acid), (G) serine, (H) alanine, (I) histidine, (J) threonine, (K) methionine (methionine sulfone), (L) valine, (M) leucine and isoleucine, (N) phenylalanine, (O) tyrosine.

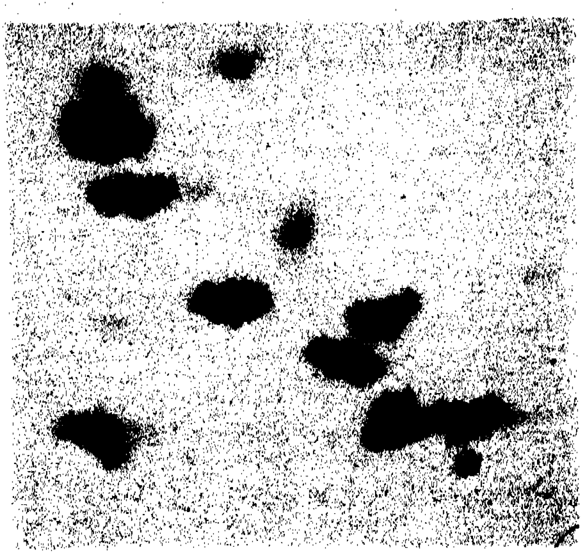

FIG. 2. Photograph of chromatogram from hydrolyzate of mouse pancreas mitochondria.

run on each sample, and comparisons between samples were made for chromatograms on which the amino acids occurring in the highest concentrations gave spots of approximately equal area and intensity, as shown in Figs. 1 and 2. Mitochondrial fractions of the liver and kidney of the mouse and rat, and of pancreas, mammary gland, hepatoma, squamous cell, and mammary carcinomas in the mouse were analyzed.

Photographs of two typical chromatograms are shown in Figs. 1 and 2. The visible constituents are identified on Fig. 1. The yellow spots given by proline and hydroxyproline are not visible on the photographs because of insufficient contrast, although they were visible on the original chromatograms. Eighteen amino acids were clearly identified on the chromatograms. Tryptophan was not observed because of destruction during acid hydrolysis. Glutamic acid, aspartic acid, glycine, alanine, serine, proline, the leucines, and valine were present in the largest quantities. Somewhat smaller amounts of lysine, arginine, threonine, phenylalanine, and tyrosine were found. Methionine, cystine, histidine, and hydroxyproline were present in the smallest concentrations.

There was a remarkable constancy in the relative amounts of the chief amino acids found in the mitochondria from the different samples of tissue examined. This is illustrated in Figs. 1 and 2, in which preparations from different organs of different species are compared. The chromatograms suggest the possibility that the rat kidney mitochondria might contain slightly more lysine and histidine and slightly less methionine than those from mouse pancreas. This will have to be checked by quantitative procedures. The patterns of amino acids found in the preparations from the malignant tissues examined were virtually identical with those obtained from normal mouse tissues.

The similarity of the amino acid patterns found in the mitochondrial fractions of the various tissues studied suggests that there is a characteristic protein, or combination of proteins, associated with these particles. The results also indicate that the quantity of the dicarboxylic amino acids exceeds that of the basic amino acids.

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On the Participation of the Reticulo-endothelial System in the Alarm Reaction

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We wish to report upon experiments which revealed a marked increase in phagocytic activity of the reticulo-endothelial system during the alarm reaction, that is, during the first phase of the general adaptation syndrome.

The reticulo-endothelial system probably participates in the defense of the organism through its phagocytic activity, and by production of antibodies, agglutinins, antitoxins, etc. (*1, 4*). A local increase in the activity of this system has been described in the thymus (*5*) after exposure to various acute nonspecific stresses, and in the spleens of rats subjected to chronic inanition (*3*) or injected with cortical extracts (*2*). Stimulated by these findings, we have performed two series of experiments in order to clarify the relationship between the reticulo-endothelial system and the hormonal and metabolic changes which occur during the alarm reaction.

In our first experiment, 44 piebald male rats (average body weight 150 g) were divided into four equal groups: group I served as untreated controls; groups II, III, and IV were fasted 48 hr, and during the last 24 hr were submitted to various stresses, such as cold (0 – 5° C), spinal cord transection (at the height of the 7th cervical vertebra), and repeated, exhaustive, forced exercise. All animals were injected intravenously with 2 ml of a dilute solution of Higgins India ink (1 part India ink to 5 parts physiologic NaCl solution) 1 hr before they were killed. At autopsy, naked eye inspection showed, in all the stressed animals, a markedly increased deposition of India ink in the lung, kidneys, adrenals, bone marrow, and the "hibernating gland." In the hibernating gland, this was accompanied by an acute discharge of lipid granules, hyperemia, and edema. These changes are characteristic of the alarm reaction and have been given special attention elsewhere (*6*). Compared to the controls, the India ink deposition in the liver of the alarmed rats did not seem to be significantly increased, while in the spleen there was a diminution of India ink deposition.

Subsequent histological examination confirmed and extended the autopsy findings. There was increased phagocytosis in the lung, kidneys, adrenals, bone marrow, hibernating gland, thymus, and lymph nodes. Phagocytosis was not increased in the hepatic macrophages of the alarmed animals. In the spleen, which undergoes marked atrophy during the alarm reaction, there was a slight decrease in the India ink phagocytosis.

In a second series of experiments, 20 piebald male rats (average body weight 130 g) were divided into four groups and treated as in the first experiment. The autopsy and histologic findings confirmed the observations already described.

The results of our experiments suggest an active participation of the reticulo-endothelial system in the defense of the organism during the alarm reaction.

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Colorimetric Estimation of Noradrenalin in the Presence of Adrenalin

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Since noradrenalin generally occurs in animal tissues in a variable mixture with adrenalin (*1, 3, 5*), it has become desirable to find methods for quantitative assay of both substances in a mixture. This can be done by taking advantage of the difference in activity ratio of noradrenalin and adrenalin on various test objects, such as the blood pressure of the cat in chloralose anesthesia, and the hen's rectal cecum (*3, 5*). Although the general type of effect is the same, noradrenalin may have 2–4 times the effect of adrenalin on the cat's blood pressure weight for weight, but only 1/10–1/50 of the activity of adrenalin on the fowl's rectal cecum. By computing the results of the assay, the relative amounts of noradrenalin and adrenalin may be estimated with a fairly high degree of accuracy. Though the biological method has the advantage of high specificity and requires only small amounts of active material, it is time-consuming and necessitates the use of at least two test animals. For this reason a simpler chemical method has been developed. The procedure given herein has been adopted as satisfactory.

The biological material is purified either by adsorption on alumina, according to the method of Shaw, modified by von Euler (*4*), or by the method of Bergström and Hansson (*2*), based on the ion-exchange principle.

The colorimetric method is based on the formation of noradrenochrome and adrenochrome on oxidation with iodine. The adrenochrome formation is complete when iodine is allowed to act for 1½ min at pH 4.0, whereas only about 10% of the noradrenalin is transformed into noradrenochrome under the same conditions. On 3-min treatment with iodine at pH 6.0, maximal formation of noradrenochrome and adrenochrome is attained.

The procedure is as follows: To an amount of purified extract containing 20–200 μg catechol derivatives, 1 ml *n*-acetate buffer of pH 4 and 0.2 ml of 0.1 *N* iodine solution is added. After precisely 1½ min, excess iodine is removed with 0.05 *N* sodium thiosulfate. The color is read within 5 min against a blank without iodine in a photometer at wavelength 529 mμ. The procedure is repeated with a second sample using acetate buffer pH 6 and 3-min iodine treatment. Standard readings are made with 100 μg adrenalin and noradrenalin at pH 4 (1½ min), and pH 6 (3 min), giving the calibration factors for both substances and the percentage of noradrenalin oxidized at pH 4 in 1½ min. At 529 mμ, the adrenochrome figure is the same on oxidation at pH 4 and pH 6.

Computation of results:

a = reading at pH 4 (1½-min iodine treatment)

b = " " pH 6 (3- " " ")

m = calibration factor for adrenalin $\left(\frac{100}{\text{reading for } 100\ \mu\text{g}}\right)$

n = " " " noradrenalin "

p = relative amount of noradrenalin oxidized at pH 4 in 1½ min

$$\left\{\begin{array}{l}\text{noradrenalin} = n \cdot \dfrac{b-a}{1-p} \\ \quad \text{adrenalin} = m\left[a-p\,\dfrac{(b-a)}{1-p}\right]\end{array}\right.$$

With mixtures of noradrenalin and adrenalin in varying proportions, the results indicated in Table 1 were obtained.

TABLE 1

Amounts added:		Calculated from readings:	
adrenalin	noradrenalin	adrenalin	noradrenalin
μg	μg	μg	μg
10	90	11.8	86.8
20	80	20.5	80.5
30	70	30.3	68.6
40	60	40.8	59.5
50	50	50.7	47.7
60	40	61.1	39.5
70	30	70.0	30.4
80	20	79.7	19.5
90	10	90.8	9.6

The method has been repeatedly tested on purified suprarenal extracts and results have agreed well with those obtained from biological methods.

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Syntheses of Isotopically Labeled 2,4-Dichlorophenoxyacetic Acid (2,4-D) and Derivatives

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The great interest in and wide use of 2,4-dichlorophenoxyacetic acid (2,4-D) in recent years has prompted us to investigate the synthesis of this compound and some of its derivatives incorporating radioactive isotopes.

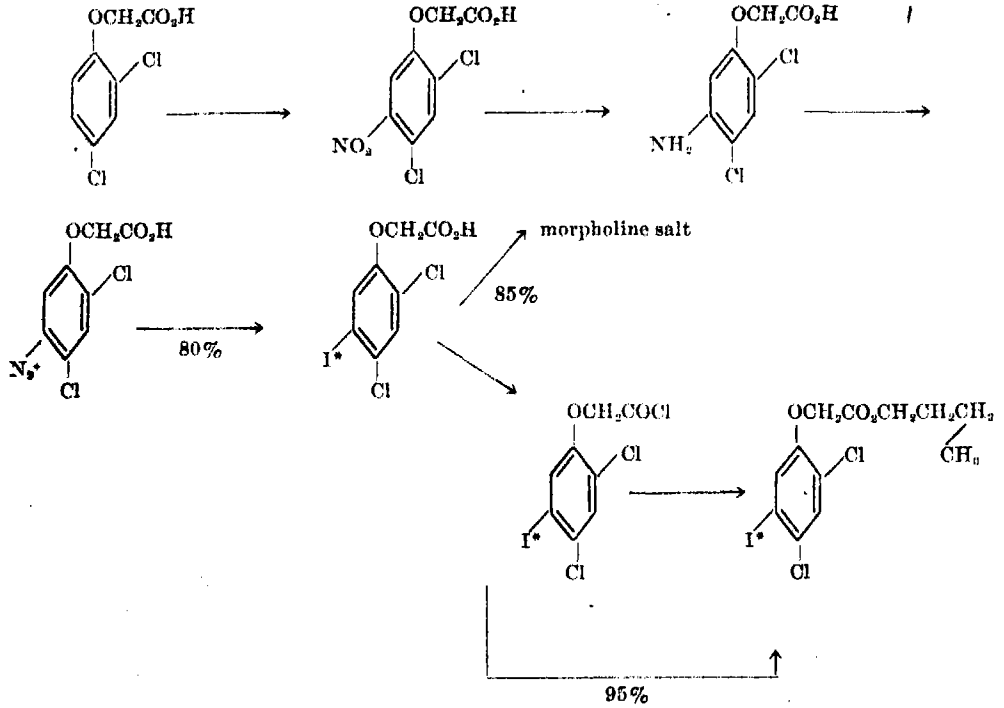

FIG. 1.

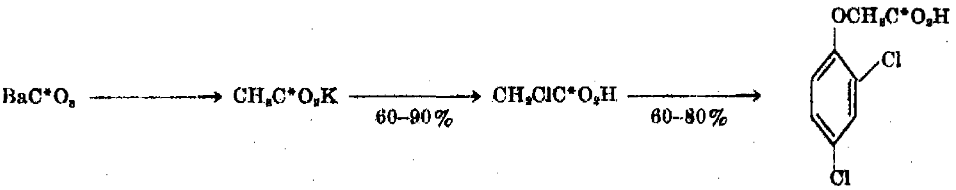

FIG. 2.

One synthesis employs radioactive I^{131} and leads to 2,4-dichloro-5-iodophenoxyacetic acid-I^{131} through the sequence of the reactions shown in Fig. 1.

The 5-amino compound was prepared as indicated (*3*), diazotized and treated with radioactive sodium iodide, diluted with inactive material, thus yielding iodine-labeled 2,4-D. The butyl ester was obtained from the free acid through the acid chloride prepared by means of thionyl chloride (*3*). In this manner we have synthesized 75 mg of the free acid, 80 mg of its morpholine salt, and 92 mg of its butyl ester, showing specific activities of 28, 23, and 24 μc/mg, respectively.

We have also developed a method leading to 2,4-dichlorophenoxyacetic acid-1-C-14 by means of the sequence in Fig. 2.

Potassium acetate-1-C-14 prepared in the conventional manner (*1*) is chlorinated in nitrobenzene, using a modification of Ostwald's synthesis (*2*). Alkaline condensation of the chloroacetic acid, which is never isolated as such, with 2,4-dichlorophenol then leads to the desired product. In this manner, 0.68 g of C^{14} labeled 2,4-D was obtained, and showed a specific activity of 1.0 μc/mg. Complete details of the work will be published elsewhere.

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Synergism of Thromboplastic Extracts: Synergistic Activity of Rabbit Lung and Brain Thromboplastic Extracts

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In the course of attempts to standardize thromboplastic materials, an apparent synergism of some of these materials was encountered. The purpose of this paper is to present evidence of such an effect in the thromboplastic activities of rabbit lung and rabbit brain mixtures.

Acetone-dried rabbit brain and acetone- or air-dried rabbit lung were extracted with 0.85% NaCl and tested on frozen plasma from normal human subjects, utilizing our modified one-stage technique of Quick. Results of volumetric mixtures of the extracts when tested in this way are shown in Table 1 and graphically in Fig. 1, curves A, B, and C.

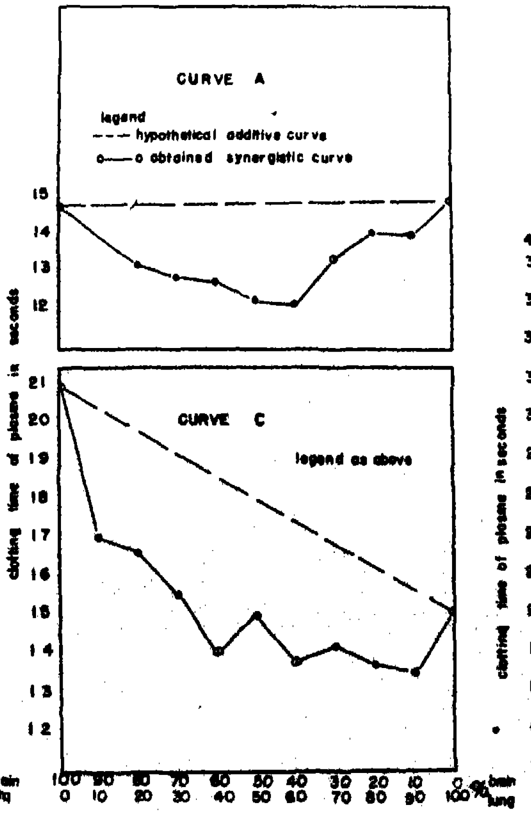
The data demonstrate that there is increased thromboplastic activity of mixtures of brain and lung extracts above that which would be anticipated by the process of mixing. This is particularly well demonstrated by curve B, where an extremely "slow" lung preparation made by acetone drying was mixed with a "rapid" brain

TABLE 1

Brain-lung ratio	PLASMA A* Observed clotting time (C.T.) in sec	PLASMA A* Calc. add. C.T. in sec	PLASMA B† Observed C.T. in sec	PLASMA B† Calc. add. C.T. in sec	PLASMA C* Observed C.T. in sec	PLASMA C* Calc. add. C.T. in sec
100B 0L	14.8		14.7		21.0	
90B 10L	——	——	14.5	17.3	17.0	20.4
80B 20L	13.2	14.8	13.8	19.8	16.7	19.8
70B 30L	12.9	14.8	13.1	22.3	15.6	19.2
60B 40L	12.8	14.8	11.9	24.8	14.0	18.6
50B 50L	12.3	14.9	12.6	27.3	15.0	18.0
40B 60L	12.2	14.9	12.7	29.8	13.7	17.4
30B 70L	13.4	14.9	13.0	32.3	14.2	16.8
20B 80L	14.1	14.9	13.8	34.8	13.7	16.2
10B 90L	14.0	14.9	15.5	37.3	13.5	15.7
0B 100L	14.9		40.4		15.1	

* Clotting time obtained with air-dried lung thromboplastin.

† Clotting time obtained with acetone-dried lung thromboplastin.



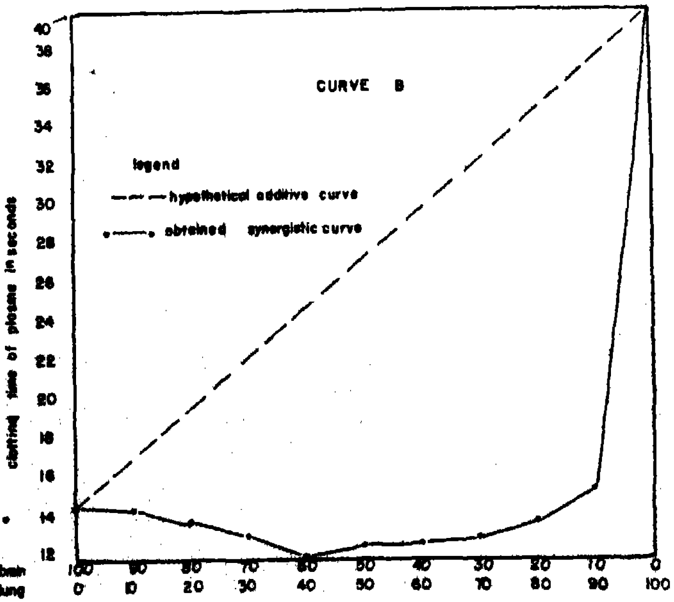


FIG. 1.

preparation. A mixture of one part of brain extract with nine parts of lung extract exhibited sufficient synergistic action to shorten the clotting time from 40 to 15 sec. The same effect is apparent in curves A and C, using more rapid initial preparations. This effect may be interpreted as due to a reshuffling of components in a thromboplastin complex, or a rebalancing of functionally different thromboplastins. The effect of various clinical conditions on the prothrombin time determined with these thromboplastins is being investigated for possible application to routine prothrombin time determinations.

The practical economic value of this effect is the possibility of increasing the yield of material from one animal several fold, and also of making available a more active preparation of thromboplastin.

These considerations apparently apply also to mixtures of brain thromboplastin. Preliminary experience in this laboratory indicates that mixtures of "deteriorated slow" brain thromboplastin with fast thromboplastin in about equal proportions give prothrombin times equal to those obtained with 100% fast brain thromboplastin. If this is borne out, much thromboplastin, now discarded, may be salvaged.

Chromatographic Analysis of a Mixture of Proteins from Egg White

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Successful separations and analyses of a wide variety of compounds have been achieved with the use of ion-exchange resins (*4*). As a result of the utilization of refractometric optical methods of observation (*8*), the chromatographic separation of protein mixtures has been predicted (*10, 15*). In fact, Tiselius has reported distinct fractionation of protein mixtures on paper by the somewhat different technique of salting-out adsorption (*14*).

This preliminary paper will outline briefly the experimental conditions used for a chromatographic analysis of a protein mixture, and its correlation with the results of an electrophoretic analysis of the same mixture, using the standard Tiselius apparatus (*12*).

The protein system studied, egg white albumin fraction (*5*), was prepared from hen's egg white by the addition of an equal volume of saturated ammonium sulfate and the subsequent removal of the precipitate formed. Just prior to use, the supernatant, which had been stored in the refrigerator, was dialyzed extensively against running tap water and two changes of 20 volumes of cold distilled water. The pH of the final preparation was 6.8.

In preparation for use, the resin, Dowex 50,[1] a cation exchanger in the 200–500 mesh size, was given successive overnight treatments with 4% ammonium hydroxide, 4% sulfuric acid, and 4% ammonium hydroxide, with extensive washing with distilled water between treatments, and a final washing with freshly boiled distilled water. The resin column was formed in one arm of a U-tube which contained a fused-in fine sintered glass disk to support the adsorbent, and was connected at the top to one arm of a standard tall center section Tiselius electrophoresis cell (*7*) through a 1-mm-diam hole in a specially made bottom section. The adsorbent column was 19.5 cm long and 6.9 mm in diam and was covered by a glass wool plug just below the sliding plate interface, connecting bottom and center sections of the modified electrophoresis cell. Just prior to the analysis, the U-tube was washed and filled with protein mixture below the sintered glass disk. During operation, protein was introduced to the bottom of the column through the U-tube from a liquid reservoir above the other vertical arm. The whole assembly, except

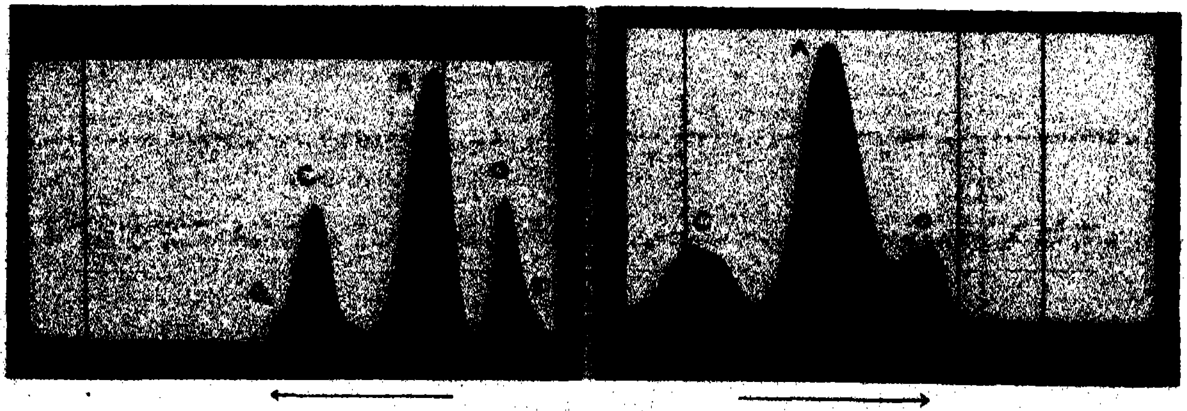

FIG. 1. *Left*, electrophoretic pattern of descending boundaries of egg white albumin fraction in 0.1 M sodium acetate —0.05 M acetic acid buffer at pH 8.90, after 8,520 sec electrolysis at 6.17 v/cm. *Right*, schlieren scanning pattern of effluent from chromatographic column during frontal analysis, flow rate 0.89 ml/hr.

G_1: globulin, C: conalbumin, A: ovalbumin, O: ovomucoid, ε: false buffer boundary. Arrows below patterns represent direction of electrophoretic migration or hydrodynamic flow.

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[1] Dow Chemical Company, Midland, Mich.

for the protein reservoir, was immersed in an electrophoresis bath thermostatically controlled at 4° C. Refractometric optical measurements were made on the effluent solution in the Tiselius cell above the column, using the schlieren scanning technique of Longsworth (*6*). This arrangement permits the application of the frontal analysis method of Tiselius and Claesson (*1*, *2*, *13*).

The electrophoretic analysis of the original albumin fraction is shown in Fig. 1, *Left*. The separation into three major components parallels the results of Longsworth, Cannan, and MacInnes (*9*).

In Fig. 1, *Right* is shown the schlieren diagram of the material emerging from the column during frontal analysis. The separation into three major components is again apparent. By means of a capillary, a sample was drawn from between the second and third peaks. Resolution of this sample in the microelectrophoresis cell (*12*) established the identity of proteins giving rise to the boundaries observed in frontal analysis.

TABLE 1

ANALYSES OF EGG WHITE ALBUMIN FRACTION

Method and sample	Ovomucoid %	Albumin* %	Conalbumin %	Total protein concn.*
Frontal analysis (original)	13.2	68.5	18.3	1.95%
Electrophoresis (original)	19.9	56.2	22.8	2.05% †
Electrophoresis (column effluent)	19.7	57.5	21.4	......

* After water dialysis, assuming specific refractive index increment of 0.00185.

† From freely diffusing boundary.

To investigate the possibility of protein denaturation by the resin, electrophoretic and ultracentrifugal analyses were also performed on material collected from the column after no further chromatographic resolution was indicated by the optical system. The schlieren diagrams obtained from electrophoretic analysis of the effluent reproduced in every detail the patterns obtained from the original egg white albumin fraction, indicating that adsorption onto and desorption from the ion-exchange resin had not altered the charge distribution of the several protein components. However, the ultracentrifuge experiments appeared to indicate that there had been small changes in the size distribution, and this remains to be investigated in more detail.

Comparison of the chromatographic analysis with the electrophoretic analyses of the original albumin fraction and of the effluent from the column is made in terms of percentage composition in Table 1. In addition, the total protein concentration of the sample shown in Table 1 was determined separately from the schlieren scanning diagram of a freely diffusing boundary which had been formed against water and compensated into view in the electrophoresis cell.

Although there is qualitative agreement between the electrophoretic and chromatographic results, it should be noted that both electrophoretic analysis and chromatographic frontal analysis are subject to quantitative errors (*1*, *3*, *8*, *11*), which have not been evaluated for the protein system used here. An investigation of the possible magnitude of the errors involved in the frontal analysis of protein mixtures with this ion-exchange resin is being undertaken by the analysis of synthetic protein mixtures. The feasibility of extending the present technique to larger scale separation of proteins is also under study.

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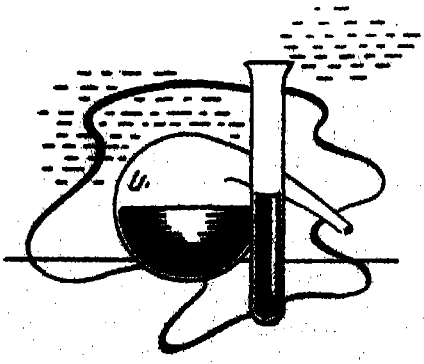

Comments and Communications

The Synthesis of Vitamin B_{12} in the Digestive System of the Sheep

Several months ago it occurred to us that a relationship might exist between cobalt deficiency disease in sheep and the fact that vitamin B_{12} contains cobalt (Smith, E. L. *Nature*, Lond., 1948, **162**, 144). Accordingly we fed one sheep 0.4 milligram of cobalt containing radioactive Co^{60}, and a second sheep 1 mg of cobalt containing traced cobalt. On subsequent examination of the feces it was found that more than half of the traced cobalt had been incorporated into an organically bound form. On treatment of the feces with 0.5 *N* HCl almost all the active cobalt could be extracted. On extraction with butanol most of the activity went into the organic solvent in a manner similar to the behavior of B_{12} obtained from liver extracts (*ibid.*, **161**, 638). Tests with inorganic cobalt show that a negligible amount passes into butanol from water solution under these conditions. Biological assay, using both *Lactobacillus lactis* Dorner (Shorb, M. S. *Science*, 1948, **107**, 397), and *Lactobacillus leichmannii*, indicated the presence of large amounts of vitamin B_{12}. Thus, sheep feces appear to be an important source of B_{12}.

We have seen the paper of L. S. Gall *et al.* (*Science*, 1949, **109**, 468), showing that the growth of certain bacteria in rumen of the sheep is stimulated by the administration of cobalt. It is tempting to assume that these rumen bacteria synthesize the B_{12}.

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Scientific Research vs. the Theory of Probabilities

There is an increasing tendency to force use of the theory of probabilities upon those engaged in scientific research. To me, scientific research is the attempt to discover and establish principles for accurate prediction of what will happen. Can we use measurements and the absolute truths of the mathematicians for accurate prediction in human or biological affairs?

To whom should one go for accurate prediction as to how long one will live? Mathematicians deal with this subject by means of the theory of probabilities, and the actuaries they train make the necessary calculations for life insurance companies. For the purposes of these companies one goes to a medical examiner to be classified as to length of life. However satisfactory for the companies these calculations and classifications may be, for the individual case the prediction may seem no better than that made by an astrologer. I was refused life insurance over twenty years ago, and the other day a neighbor was accepted for life insurance in the morning and died going upstairs in the afternoon!

The prestige of mathematics is so great that many persons forget that even in mathematical hands, *probability*, *chance*, and *random* mean ignorance. They come to think that, in the alembic of mathematics, chance in some way becomes certainty. They take great care to select random samples without realizing that, insofar as a sample has been random, they don't know how it was selected.

The biologist's greatest gift from mathematics might well be, not a theory that may delude him into belief that he is wise when he is ignorant, but rather the ideal of clear definition and precise use of his terms and symbols, not excepting *science* and *research*. When we are faced with discrepant results in our handling of facts, four courses are open to us. First, we may gloss over our failure in prediction by saying that the exception proves the rule. Second, we may abandon our principle of prediction and fold our hands. Third, we may hold onto that principle and by piling up results and treating them mathematically try to show accurately, for intellectual satisfaction or for practical action, just how much or how little the principle determines what happens. Scientists who content themselves with testing theories or supposed principles can well use the theory of probabilities and may call this scientific research. To go no further is to abandon the search for new principles that may permit accurate prediction in the individual case.

Finally, we may be stimulated by the discrepancy between our results and our expectations to discover unknown principles; this will be true scientific research. It is to be contrasted with, not assisted by, use of the theory of probabilities. The latter is a most valuable tool for practical action on the basis of current knowledge and current ignorance.

A. G. HUNTSMAN

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Name of the Soybean

J. Paclt (*Science*, 1949, **109**, 339) has proposed that the name *Glycine Max* (L.), as used for the soybean, be rejected as having been based on a *nomen confusum* (*Phaseolus Max* L.) and that the name *Glycine Soja* (L.) Sieb. et Zucc. be taken up in its place. Perhaps no plant has been subjected to more nomenclatorial buffeting and name-changing than has the soybean—a situation that always is unfortunate, and the more so for a plant of economic importance. In a more recent extensive accounting for the correct name of this plant I have presented detailed analyses to support the contention that the legitimate name of the soybean is *Glycine* Max (L.) Merrill (Lawrence, G. H. M. *Gentes herbarum*, 1949, 8 *fasc.* 1.)

The name of the soybean dates from 1753 when, in his

Species plantarum, Linnæus designated it as *Phaseolus Max.* The description he gave is of itself inadequate. Paclt alluded to the presence in this description of "some specific characters derived from another element, namely *Phaseolus Mungo* L." In the absence of specific details in support of his claim, it is indeed hazardous to accept his contentions and, contrary to his statement, I know of no contemporary botanists who treat the mung bean as conspecific with the soybean. Offsetting this deficiency in his description of 1753, the earlier references cited by Linnæus and the available type specimen of the plant make clear the identity of the soybean. Careful study of them fails to indicate the basonym of *Phaseolus Max* L. to be a *nomen confusum.* The specimen of *Phaseolus Max,* on which Linnæus based his name, was provided him by George Clifford, and is currently reported to be in the Linnæan herbarium. The more ample description by Linnæus in *Hortus Cliffortianus* (1738) is presumed to have been based on the same Clifford specimen, and this earlier account may serve to supplement the inadequate diagnosis in *Species plantarum.*

It is the opinion of Paclt (*loc. cit.*) and, for wholly different reasons, of Hill (*Bot. Mus. Leaflets Harvard Univ.,* 1939, 7, 107) that the name of the soybean is *Glycine Soja* (L.) Sieb. et Zucc. The name as used contemporarily, and not originally by Siebold and Zuccarini, was based on *Dolichos Soja* L. As was true of *Phaseolus Max,* Linnæus provided only a fragmentary description of *Dolichos Soja* in his *Species plantarum,* but cited his earlier and identical description as given in the *Flora Zeylanica* (1747). This earlier description was based on a specimen collected from cultivation in Ceylon by Paul Herman prior to 1677. After Linnæus' time the wild indigenous prototype or counterpart of the soybean became known to science. Moench (1794) considered it distinct from the cultigen and named it *Soja hispida.* In 1845 Siebold and Zuccarini treated the same plant under the new name of *Glycine Soja.* This is a case involving two different types of specimens collected from two divergent geographic regions: *Dolichos Soja* L. from cultivation and *Glycine Soja* Sieb. et Zucc., an indigen. Other early botanists considered the two plants to be different entities; later botanists have treated them as conspecific. However, by Article 18 of the Rules of Botanical Nomenclature, we are not allowed to take up a name based on a different type from that accepted by the author of the name. Siebold and Zuccarini clearly excluded Linnæus' *Dolichos Soja* from their concept of *Glycine Soja.* It is most unfortunate that they chose the name *Soja* for their plant. Because of these circumstances it is incorrect to cite Linnæus as a parenthetical author of their binomial.

I have attempted to refute Paclt's contention, unsupported by requisite data, that *Glycine Max* (L.) is based on a *nomen confusum* and to show that in no case is the name *Glycine Soja* Sieb. et Zucc. available as a legitimate name for the soybean. It seems clear to me, until such time as the case may be reviewed and an opinion given by more competent authority, that we should continue to designate the soybean as *Glycine Max* (L.) Merrill.

GEORGE H. M. LAWRENCE

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A Six-Segment Head Regenerate in a Supposedly Refractory Earthworm Species, *Lumbricus castaneus* Savigny 1826

It has been shown (Carpenter, E. *Science,* 1948, 108, 625), that, contrary to general belief, a head of six segments may be regenerated in the manure worm, *Eisenia foetida* (Savigny) 1826. This species, in proper laboratory conditions, regenerates readily and rapidly. *Lumbricus castaneus,* however, has been thought to have little or no regenerative capacity, presumably because of Hescheler's failure to secure regeneration (*Z. Nat.,* Jena, 1896, 30, 177).

Material was secured from a pile of old leaves behind a Harvard building. Experimental conditions were the same as for *E. foetida* (Gates, G. E. *Biol. Bull.,* 1949, 96, 129), except that in this case all regeneration was terminated at 30 days. The species has been found only twice in the U. S., and inability to secure further material ended the experiments.

All posterior substrates with transections at levels from 4/5 to 7/8 inclusive survived and regenerated (no operations behind 7/8). Regenerates at 4/5 or 5/6 had little or no metameric differentiation. Regenerates at the next two levels were normally cephalic, of three (1 specimen) and four segments (1) at 6/7, and at 7/8 of six (1) and 5½ (1) segments. In the latter case the half-segment was wedge-shaped and on the left side. The prostomium of each regenerate, apparently completely differentiated, was epilobic, rather than tanylobic as supposedly characteristic of the genus *Lumbricus.*

Regeneration of a normal head of six segments at 7/8 enables prediction of a species capacity to regenerate equimeric heads at 6/7 and all levels anteriorly.

A six-segment-head regenerate from such a limited number of operations, on a supposedly refractory species, seems to warrant another prediction, namely, that further investigation will show that the capacity for head regeneration, throughout the family Lumbricidae, has been underestimated.

G. E. GATES

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Determination of Condition of Oysters

It is difficult to devise a method of evaluating the condition of an organism by making analyses of only a few of the factors concerned. A recent publication by Robert M. Ingle (*Science,* 1949, 109, 593) illustrates the nature of this problem in the extensive researches now being made on oysters.

Ingle mentioned that "later workers have adopted the measurement of glycogen content as a supplementary method of evaluation," meaning supplementary to the "index" method, as explained herein, which was developed by the writer and published in brief form in 1938 (in Higgins, E. *Rep. Commis. of Fish,* 1937). The glycogen method is the traditional one and has been employed by various investigators—P. H. Mitchell (*Bull. U. S. Bur. Fisheries,* 1917, 35, 151), P. S. Galtsoff *et al.* (*Bull. U. S. Bur. Fisheries,* 1935, No. 18), and others.

It was because of the apparent unreliability of the glycogen method that the more recent index procedure was put into use.

Ingle objected to the index method because his graph, in which he plotted index values against percent of glycogen, did not indicate a uniform relationship. The figure clearly proves his point, and in doing so should suggest the obvious conclusion that there is no reason for expecting the two methods to give comparable results. It would be very surprising should they do so, in which case the need for the index method would not have arisen.

In applying this method, calculations are also made of the ratio of meats undrained and drained to the volume of the shell cavity. However, it has been found consistently that, because of osmotic effects from changes in salinity, the condition of an oyster, or of a group of oysters, as usually employed, may well be expressed by the equation referred to by Ingle, namely,

$$\text{Index} = \frac{100 \times \text{Dry weight (g)}}{\text{Volume shell cavity (cc)}}$$

The index method was specifically designed to give a picture, not of the glycogen cycle throughout the year, but of the actual quality of meat when reduced to a dry basis, in order to eliminate errors due to osmotic effects, maturation of gonads, and spawning.

In further support of this point it is of interest to mention the following figures on analyses of oyster meats (Chatfield, C., and Adams, G. *U. S. Dept. Agr. Circular No. 549*, 1940): "protein, 9.8%; fat, 2.0%; carbohydrate (glycogen), 5.9%." These figures definitely refer to drained oysters during the winter season as used commercially, but they indicate that glycogen constitutes only about one-third of the tissue substance. The method of glycogen analysis ignores proteins completely, though they are nearly double the glycogen; while the index method measures the entire amount of meat.

A. E. HOPKINS

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Effect of Dioxane and Sodium Hydroxide upon Lens Capsule and Cortex (*Squalus* sp.)

The use of these chemicals in conjunction with the study of the lens may complement certain laboratory activities in physiology and comparative anatomy. To demonstrate specific peculiarities of the lens the following procedures can be followed during the regularly scheduled laboratory periods without interrupting the prescribed requirements.

A certified grade of dioxane should be used for optimum clearing of the lens structures. Appreciably fine results may be obtained from salvaged dioxane, if it is dehydrated with CaO and filtered before using. Dioxane and water are miscible in all proportions, but a more uniform infiltration occurs if the lenses are suspended in the medium rather than allowed to rest on the base of the vial. This caution should be observed if reclaimed dioxane is used.

The type of lens utilized in these procedures may be obtained from the commercially preserved dogfish. The lens must be carefully removed from the eye to avoid injuring the lens capsule. It is then immersed in the dioxane for 10 min, removed, and air-dried.

A lens so treated will appear as a clear, pale amber, uniformly homogenous structure. In this condition it is impossible to distinguish the capsular, cortical, or nuclear components because of their uniform transparency. Very faint striations and suture lines may, however, be observed on the surface of the capsule with the aid of a hand lens. This preparation, because of its clarity, serves most efficiently for the demonstration of the refracting and focusing powers peculiar to lenses.

If the capsule is mechanically scratched or broken, and the specimen again immersed in dioxane for 25 min, white opacities, comparable to cataracts, appear upon the cortical surface. Excessive exposure to dioxane will render the entire specimen white.

Further observations pertaining to the cortex may be facilitated by the use of 20% NaOH solution. The lens should be placed in the alkali for 15 min, then washed and dried. This treatment will clearly reveal the capsular suture lines.

If the alkaline-treated lens is observed before drying, the lamellated character of the slightly swollen cortex is readily seen; and it may easily be peeled. The removal of the cortical strata will expose the nucleus, which is a transparent, amber, homogenous unit, free of striations and lamellations.

By holding the moist lens against the light before removing the cortex, the shiny nucleus may be seen almost centrally located within the gelatinous cortical envelope.

Prolonged exposure of the lens to the alkali, 24 hr, will cause a gross swelling of the cortex and of the nucleus, and a change from the clear state to a uniformly hazy condition.

This procedure provides a means of more completely utilizing the lens when the structure of the eye is studied in comparative anatomy; and a means, also, of demonstrating the refractive powers, cataracts, and other lens characteristics in physiological applications.

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D. S. PO-CHEDLEY

Book Reviews

Economic geography of the USSR. S. S. Balzak, V. F. Vasyutin, and Ya. G. Feigin. (Eds.) New York: Macmillan, 1949. Pp. xlv + 619. (Illustrated.) $10.00.

This is a volume which opens with a quotation from Stalin, and closes with reference to polar fliers who "are ready, if it becomes necessary, to transfer from civilian to military planes and destroy the enemy, wherever he may be." Between these two items, unusual in a volume of economic geography, are four comprehensive chapters on natural resources, industry, agriculture, and transport as seen by the geographer, plus three ideological treatises on the Soviet interpretation of production and population under tsar and socialism.

Economic geography of the USSR is nonetheless valuable if it combines excellent geography with partisan ideas, for the Soviet lands cannot be understood without both. With major reservations, this promises to be the definitive volume on Soviet geography. It was originally published in 1940, largely with 1935 data, and is here translated under the auspices of the American Council of Learned Societies with the editorship of Chauncy D. Harris. This is the only comprehensive geography of the Soviet Union ever to be published in Russian and its translation is a major event. Fifty-three tables, 83 maps, and six appendices provide a wide array of information nowhere else available; in fact, the American translators have materially enriched the original volume.

It is now clear that the USSR is second only to the USA in the wealth of its resources:

> Thus, the USSR has diverse natural conditions and natural riches such as are possessed by no other country in the world. "From the standpoint of natural wealth, we are completely secure. We have even more than we need." But in order to put these natural riches completely into the service of the working people, in order to create an abundance of all kinds of products, "there must be a government with the desire and the power to direct the utilization of this huge national wealth for the benefit of the people. Do we have such a government? We do."

(Quotation from Stalin.) What is also clear, although not stated by the authors, is that limitations of cold, drought, and continentality place permanent restrictions on economic developments. One might suggest that in academic terms, the best "grade" the Soviet lands may hope to receive under any conditions of government is no better than an A–. This is, to be sure, a creditable rating, although not yet achieved.

Two sentences, chosen at random, reflect Soviet thinking:

> The capitalist town subjugated the village and artificially retarded its cultural development. For this reason, in the eyes of the peasants the town was always the focus of their exploitation. . . . The Marxist-Leninist understanding of the role of the natural-geographic environment has nothing in common with crude geographic theories . . . as explained by bourgeois geographers and economists. . . .

George B. Cressey

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Veterinary helminthology. Banner Bill Morgan and Philip A. Hawkins. Minneapolis 15, Minn.: Burgess Publ., 1949. Pp. ix + 400. (Illustrated.) $7.00.

Everyone who deals with animals knows that there is a whole world of parasitic life associated with them. Probably everyone but a specialist with a bulging reprint library, however, would be astonished to know what an extraordinarily abundant and diverse part of this fauna the helminths represent. Morgan and Hawkins, in their text and reference book, have undertaken the formidable task of digesting this literature with reference to "animals of veterinary importance in North America" for the first time. The result is an impressive 400-page volume of encapsulated information, concerning both hosts and worms, species by species.

Following a general introduction (36 pp.) there are chapters on the helminths of the horse (32 pp.), of cattle (38 pp.), of sheep and goats (55 pp.), of swine (36 pp.), of the dog and cat (57 pp.), of poultry (45 pp.), of fur bearers (44 pp.), and on diagnosis (20 pp.). There is an appendix, principally of host lists (13 pp.), and a comprehensive index (14 pp.).

The authors deal with over 130 genera and about three times that many species. Drawing on an extensive teaching experience, they present for each species selective information—so far as possible—on synonyms, common name, disease, morphology, life history, symptoms, pathology, diagnosis, treatment, and control. Supplementing the text are keys for identification of various groups and life history stages, and 63 plates of line drawings and maps. From the degree of attention accorded them, the parasites of greatest interest in this field in America are *Fasciola hepatica, Moniezia expansa, Oesophagostomum columbianum, Haemonchus contortus, Trichostrongylus colubriformis, Ascaris lumbricoides, Trichinella spiralis, Ancylostoma caninum,* and *Dirofilaria immitis.* Besides emphasis on the veterinary problem, as such, relationships between parasitized domestic and wild animals and helminthic infections of man are considered.

The volume is a useful encyclopedic work, although it shows, as a first edition, certain rough spots in phrasing and proofreading. One is tempted even in a general review to raise a few questions, however. An idea tacit throughout the presentation seems debatable in our present understanding of worm-host relations—namely, that "an animal infected with worms is *suffering* from helminthiasis" (italics by reviewer). The verb implies as a rule more than is frequently true physiologically. Immunizing infections with worms are briefly discussed, and whereas up to now artificial immunization has not been as fruitful a procedure with helminths as with certain other parasitic agents, it is scarcely correct to say that "the introduction of suspensions of helminths or dead helminths into the host has not resulted in the production of any immunity" (p. 7). One misses a chapter on the ever present problem of cross infection of hosts capable of parasitization by the same helminthic species. Compartmentalization host by host is a marked convenience for discussion, but doesn't adequately reflect the way of nature. For instance, horses, cattle, sheep, and goats all harbor the minute *Trichostrongylus axei*, which may on occasion have its degree of pathogenicity obscured by attention centered on the larger helminths. Do these hosts "suffer" equally by infection with this nematode? If unequally, is the placing of horses in infested cattle or sheep pastures a danger, or means of control? Is the reverse order of pasturing advisable?

In regard to cross infections to man, the indication that *Taenia saginata* (p. 80) may cause human cysticercosis as a blind alley infection with a facility equal to that of *T. solium* (p. 167) is unwarranted, a point especially unfortunate as to cerebral cysticercosis, in which the pork tapeworm alone has been implicated. Moreover, the statement that for *Hymenolepis nana* "rodent and human forms are interchangeable" (p. 337) is counter to currently available evidence. If there were no other domestic animal reservoir of helminthic infection for man than the hog for *Trichinella spiralis* we would still have a challenging public health problem, and there is need for caution in emphasizing forms of no demonstrable threat.

Such errors have a tendency to emerge where authors so obviously strive toward simplification of statement in a complex subject. It is easy to overdo simplification and the unqualified declarative sentence strikes this reviewer as having been rather too freely employed. What is wrong with the occasional use of the interrogation point in textbooks?

The helminths of domestic animals are going to be with us for a long, long time. And, as an experimental area, veterinary helminthology offers unsurpassed opportunities to explore biological and practical angles of worm-host relationships. Not a few of these can contribute to central problems in which the human host has a very great interest indeed. Morgan and Hawkins have helped specifically to open these areas to further exploration.

NORMAN R. STOLL

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Personal adjustment in old age. Ruth Shonle Cavan, Ernest W. Burgess, Robert J. Havighurst, and Herbert Goldhamer. Chicago: Science Research Associates, 1949. Pp. xiii + 204. $2.95.

The purposes of this volume are (1) to define and analyze the nature, pattern, and problems of individual adjustment to aging; (2) to present certain facts about old age obtained from census data and a special survey by the authors; and (3) to describe two questionnaires used for measuring the adjustment of the senescent and senile. Its contents are of particular interest to physicians, psychologists, sociologists, and social workers. The authors have neither pioneered in an entirely new field nor have they produced a definitive work, but theirs is a valuable contribution to the rapidly growing literature on geriatric sociology.

Problems of adjustment in old age and the techniques for developing a valid instrument for their measurement are discussed in considerable detail. Two instruments devised by the authors, an "Inventory of Activities" and an "Index of Attitudes," although admittedly imperfect, are the basis for much of the data in this study. The statistical treatment is thorough but a succinct summary of results is lacking. The check list for the detection of neuroses is of questionable value, since it lists many symptoms also characteristic of the organic disorders frequently found in elderly persons. In the discussion of adjustment cycles in old age it is assumed that during middle age the individual has been both personally and socially well adjusted. This assumption is, of course, entirely unwarranted and ignores the continuity of emotional difficulties from one period of life into the next. The "Index of Senility" is open to serious criticism, for it contains a large number of nonspecific items which might be misconstrued. In summary, *Personal adjustment in old age* is an interesting book, but it should be read critically rather than taken at its face value.

S. T. KIMBLE

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Mathematical foundations of statistical mechanics. A. I. Khinchin. (Trans. from the Russian by G. Gamow.) New York (19): Dover Publs., 1949. Pp. viii + 179. $2.95.

Introduction to statistical mechanics. G. S. Rushbrooke. New York: Oxford Univ. Press, 1949. Pp. xiii + 334. $5.50.

These two books stress different aspects of statistical mechanics, and they are written for two different groups of readers. Khinchin's book is written primarily for mathematicians, while Rushbrooke's text is intended for students of physical chemistry.

The main interest for a physicist in Khinchin's book will probably lie in two points. The more important of these is Khinchin's discussion of the ergodic problem. The second point is his discussion of the order of magnitude of the terms usually neglected. The importance of this can be seen from Schubert's recent criticism of Gentile's intermediate statistics (*Z. Naturforschung*, 1946, 1, 113).

It is, however, to be doubted whether Khinchin's book will find a wide audience, apart from mathematicians wanting to get acquainted with statistical mechanics, or physicists wishing to brush up their knowledge of the ergodic problem. The book is written without a physical background and deals only with classical statistic mechanics, while it might have been hoped that this treatise could have supplemented the masterly analysis of the Ehrenfests in the *Encyklopaedie der Mathematischen Wissenschaften.* However, the typical quantum mechanical problems are not discussed at all, and the footnote on page 51 shows that Khinchin's understanding of these problems is limited. A nearly total lack of references makes the book very impractical to use. For instance, it is nowhere stated where one can find the important Birkhoff theorem—the center piece of the whole book, in my opinion. For the interested reader, the reference is: *Proc. nat. Acad. Sci.*, Wash., 1931, 17, 656.

Dr. Gamow's own Russian background at times peeps around the corner, e.g., when the name Birkhoff is also transcribed (from the Russian transcription) as Virkoff on page 27. To call the ideal gas law Clapeyron's law (p. 121) should not have been permitted by Dr. Gamow, who must know that Clapeyron was only 3 years old when Gay-Lussac first announced his law in 1802.

Rushbrooke's book can be highly recommended as a textbook for intermediate courses in statistical mechanics. It is comparable to Mayer and Mayer's book, but is not as extensive as this widely used text. The mathematics is kept simple and a great number of exercises at the end of each chapter greatly increase its usefulness.

For the sake of simplicity, the author has given up rigor. Characteristic of the tenor of the book is the author's statement in a footnote on p. 58: ". . . this naive statement is not seriously misleading, and conveys the correct idea."

It is a great pleasure to see a text on statistical mechanics which strongly advocates the use of Gibbs' grand ensembles. In this connection it is strange that on page 268 de Boer's work is not mentioned explicitly. The absence of Fowler's monograph in the list of standard treatises is rather surprising, since it is practically the only text referred to in British papers in the field. It is strange to me that the old quantum mechanical statistical mechanics is used, instead of the Fermi-Dirac and Bose-Einstein statistics, as the basis of this treatise and as a basis for the subsequent transition to classical statistics—but this is certainly a minor point, which does not affect the great value of Rushbrooke's text for those students who wish to get acquainted with the basic ideas of statistical mechanics.

D. TER HAAR

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Association Affairs

The New York Meeting, December 26–31, 1949

The Science Theater

The AAAS Science Theater, now a permanent feature of the Association's annual meetings, will show recent scientific films almost continuously throughout the meeting period. Hours are: December 26, 2:00 p.m. to 6:00 p.m.; December 27, 9:00 a.m. to 1:00 p.m. and 2:00 p.m. to 10:00 p.m.; December 28, 29, and 30, 9:00 a.m. to 1:00 p.m. and 2:00 p.m. to 6:00 p.m.; December 31, 9:00 a.m. to 1:00 p.m. Seating is at any time. The schedule has been so arranged that programs given in the first half of the week are repeated in the second half, and shifted from morning to afternoon, to give registrants another chance to see films that interest them.

The Science Theater is on the 18th floor of the Hotel Statler, just back of the express elevators. The capacity of this room is limited, so that admission, although free, is restricted to registrants. Showing a registration receipt will do, but wearing a badge will save time.

The Association is greatly indebted to all those who made these pictures and lent them for showing. Special appreciation is due the First District Dental Society of New York for making available its lecture room and screen.

The schedule follows:

Program 1

Monday afternoon, December 26

2:00 p.m.–6:00 p.m.

1. *Nagana*—South African Scientific Liaison office. Sound, color, 25 minutes.
2. *Anterior Dislocations of the Shoulder*—Davis & Geck, Inc. Silent, color, 41 minutes.
3. *Meiosis*—Arthur T. Brice. Sound, black and white, 19 minutes.
4. *Safety in the Chemistry Laboratory*—Indiana University. Sound, black and white, 15 minutes.
5. *Solar Prominences*—University of Michigan. Sound, black and white, 11 minutes.
6. *Conquest of the Hudson*—Port of New York Authority. Sound, black and white, 20 minutes.
7. *Then It Happened*—U. S. Forest Service. Sound, color, 10 minutes.
8. *Avian Cecal Coccidiosis*—Ohio State University. Silent, color, 30 minutes.
9. *Bound for the Caribbean*—Royal Dutch Air Lines. Sound, color, 45 minutes.

Program 2

Tuesday morning, December 27

9:00 a.m.–1:00 p.m.

1. *Amputation Prostheses and Their Uses. I*—Medical Section Headquarters, 1st Army, Governor's Island, New York City. Sound, black and white, 34 minutes.
2. *Story of DDT*—British Information Services. Sound, black and white, 25 minutes.
3. *Radar Detection of Storms Occurring in the New England Area*—Massachusetts Institute of Technology. Silent, black and white, 20 minutes.
4. *Stepping Along with Television*—American Telephone and Telegraph Company. Sound, black and white, 11 minutes.

5. *Brownian Movement*—Army Chemical Center. Silent, black and white, 15 minutes.
6. *Story of Palomar*—California Institute of Technology. Sound, color, 40 minutes.
7. *Skin Antiseptics*—Chilean Iodine Educational Bureau. Sound, black and white, 30 minutes.
8. *Cell Division*—Arthur T. Brice. Sound, black and white, 16 minutes.
9. *Surgical Approach for Hypertension*—Garfield Memorial Hospital. Sound, color, 20 minutes.
10. *Colour*—British Information Services. Sound, color, 14 minutes.

Program 3

Tuesday afternoon, December 27

2:00 p.m.–6:00 p.m.

1. *Image Dissector Motion Pictures at Ten Million Frames per Second*—University of Rochester. Silent, black and white, 15 minutes.
2. *Amputation Prostheses and Their Uses. II*—Medical Section Headquarters, 1st Army, Governor's Island, New York City. Sound, black and white, 34 minutes.
3. *Story of Lubricating Oil*—U. S. Bureau of Mines. Sound, color, 21 minutes.
4. *Charting the Seas*—British Information Services. Sound, black and white, 24 minutes.
5. *Crystal Clear*—American Telephone and Telegraph Company. Sound, color, 20 minutes.
6. *Studies of Specificity of Nonhemolytic Streptococci in Relation to Idiopathic Epilepsy, Schizophrenia, Encephalitis and Poliomyelitis*—E. C. Rosenow. Silent, black and white, 20 minutes.
7. *Principles of Electricity*—General Electric Company. Sound, black and white, 40 minutes.
8. *On Time and Light*—Henry M. Lester. Silent, color, 20 minutes.
9. *The Hurricane Circuit*—U. S. Department of State.

Program 4

Tuesday evening, December 27

6:00 p.m.–10:00 p.m.

1. *Artificial Insemination of Rabbits and Transplantation of Rabbit Eggs*—Worcester Foundation. Silent, color, 20 minutes.
2. *Gift of Green*—Sugar Research Foundation. Sound, color, 20 minutes.
3. *Life History of the Rocky Mountain Wood Tick*—U. S. Public Health Service. Silent, color, 45 minutes.
4. *Jet Propulsion*—General Electric Company. Sound, color, 15 minutes.
5. *Wyoming and Its Resources*—U. S. Bureau of Mines. Sound, color, 30 minutes.
6. *Conquering the Jungle*—Goodyear Tire & Rubber Company. Sound, black and white, 10 minutes.
7. *Amputations for Occlusive Arterial Disease*—Davis & Geck, Inc. Silent, color, 30 minutes.
8. *Project 5-4040, High-speed Studies of Safety Glass*—Monsanto Chemical Company. Sound, color, 18 minutes.
9. *Exploring with X-Rays*—General Electric Company. Sound, black and white, 40 minutes.

Program 5

Wednesday morning, December 28

9:00 a.m.–1:00 p.m.

1. *Highway to Alaska*—Allis-Chalmers Manufacturing Company. Sound, color, 23 minutes.
2. *Millions for Safety*—Port of New York Authority. Sound, black and white, 10 minutes.
3. *This is Nylon*—E. I. du Pont de Nemours & Company. Sound, color, 29 minutes.
4. *Timber and Totem Poles*—U. S. Forest Service. Sound, color, 10 minutes.
5. *Voice Sentinel*—American Telephone and Telegraph Company. Sound, black and white, 16 minutes.
6. *Nevada and Its Resources*—U. S. Bureau of Mines. Sound, color, 31 minutes.
7. *The Story of Tin Plate*—U. S. Bureau of Mines. Sound, color, 21 minutes.
8. *They Also Serve*—American Medical Association. Sound, black and white, 15 minutes.
9. *Pacific Halibut Fishing*—U. S. Fish & Wildlife Service. Sound, color, 12 minutes.
10. *Application of Cinefluorography*—R. F. Rushmer. Silent, black and white, 10 minutes.
11. *One Second in the Life of a Hummingbird*—New York Zoological Society. Silent, color, 15 minutes.
12. *Baby from Borneo*—New York Zoological Society.
13. *This is Their Story*—Film Program Services (Unesco). Sound, black and white, 20 minutes.

Program 6

Wednesday afternoon, December 28

2:00 p.m.–6:00 p.m.

Same as Program 2.

Program 7

Thursday morning, December 29

9:00 a.m.–1:00 p.m.

Same as Program 1.

Program 8

Thursday afternoon, December 29

2:00 p.m.–6:00 p.m.

Same as Program 4.

Program 9

Friday morning, December 30

9:00 a.m.–1:00 p.m.

Same as Program 3.

Program 10
Friday afternoon, December 30
2:00 p.m.–6:00 p.m.
Same as Program 5.

Program 11
Saturday morning, December 31
9:00 a.m.–1:00 p.m.
Selections from Programs 1–5.

NEWS and Notes

Reports on Antiseptics Conference, New England Geologists' Meeting, and Optical Society Meeting

A Conference on Mechanism and Evaluation of Antiseptics was held October 28–29 under the sponsorship of the Section of Biology of The New York Academy of Sciences. A registered attendance of 518 was reported by Herbert L. Davis, of the Ethicon Suture Laboratories, conference chairman.

The purposes of the conference were: (a) to summarize and evaluate existing information on the mode and extent of antimicrobial agents *in vitro* and *in vivo*, and (b) to reveal those avenues of investigation likely to produce more active compounds and more effective application of them. Perhaps the most significant outcome of the conference was the general acceptance of the view that the action of antimicrobial agents is governed significantly, if not primarily, by the principles of colloid chemistry, whether these agents be rapidly lethal disinfectants, skin antiseptics, or chemotherapeutic drugs. Living organisms are colloid structures, and antimicrobial substances of both biological and synthetic origin must first be adsorbed on or in the organism. Although some of the mechanisms of antimicrobial action, such as protein coagulation and poisoning of essential enzyme systems, are well recognized, others are only suggested by present evidence. Of particular interest is the observation made in several separate studies that adsorbed substances alter the permeability of the cell wall, causing release of bacterial protein, other nitrogenous materials, and electrolytes. Thus, the cell is no longer in equilibrium with its environment. It became increasingly clear during the sessions that empirical testing of compounds should yield to a systemic and rational study of the mechanisms by which existing antimicrobial substances act.

The 25 papers presented at the conference dealt with a wide variety of compounds, including antibiotics, cationic, anionic, and nonionic agents of high surface activity, halogens, heavy metals, and ethyl alcohol. Several authors emphasized the frequent lack of correlation between results with antiseptics *in vitro* and *in vivo*. Because results *in vitro* are frequently false due to inadequate test conditions, considerable discussion concerned the need and continued search for better antiseptic neutralizers with which to distinguish between bacteriostatic and bactericidal effects. It was generally agreed that once activity *in vitro* is established the crucial tests are those which simulate actual clinical use. Here toxicity to tissue is of primary importance, but there is still disagreement as to the proper type of tissue to use. One new procedure which directly measures the prevention of sepsis *in vivo* was presented at the conference and well received.

Microbial populations are heterogeneous in that the constituent cells possess varying degrees of resistance. This is not a new concept, but one too frequently ignored in the field of disinfection. One paper at the conference explored the nature of this variation and the factors influencing it; another proposed that the commonly applied all-or-none end point be replaced by a less severe criterion of antiseptic usability, the count of surviving organisms.

This report would be incomplete without mention of the fact that the value of ethyl alcohol as an antiseptic and disinfectant was reaffirmed and that the addition of antiseptics to 70 percent ethanol failed in some instances to increase activity. Another point of interest was the reported antiviral activity of several types of antiseptics.

There emerged from the conference a clear recognition that a whole panel of tests are necessary to establish the value of an antiseptic, and that the greatest emphasis should be placed upon those procedures *in vivo* which measure prevention of sepsis. It was equally apparent, however, that many fundamental problems remain almost untouched. It is not known, for example, whether the same or different mechanisms are involved when bacteria are rapidly killed by a strong concentration but merely inhibited by a weaker one. Nor was any new information presented as to how bacterial spores are destroyed.

EARLE H. SPAULDING

New England Field Geologists. More than 165 geologists, representing 20 colleges, attended the 42nd annual field meeting of the New England Intercollegiate Field Geologists, meeting October 14–16, 1949. Robert L. Nichols and Charles Stearns, Department of Geology, Tufts College, were hosts and were assisted by Marland P. Billings, Harvard University, L. W. Currier, U. S. Geological Survey, and Robert Shrock, Massachusetts Institute of Technology.

Prof. Shrock led a group on Friday afternoon to study the critical exposures of the well-known Squantum tillite complex which is, in places, underlain by similar rock in which thin bedding, interpreted as varves, is developed. Other microstructures in tillites and associated stratified rocks were studied.

The lithology and stratigraphy of the area surrounding the Chemsford granite were discussed at selected points by a group led on Saturday by L. W. Currier. Problems of granitization and the relative degrees of "invasive metamorphism" were noted. The stratigraphic sequence of rocks in the area was noted, and it was illustrated on the trip that 1) pebbles of the Merrimack quartzite (oldest in series) occur in the overlying Harvard conglomerate; 2) that the Harvard conglomerate, at the base of the Worcester phyllite, should be considered a local member of the phyllite; 3) that this phyllite grades upward into the Brimfield schist; and, that the schist grades upward into a paragneiss. Correlation of the Merrimack with the Oakdale quartzite farther southwest and with the Kittery quartzite to the northeast was suggested. Characteristic outcrops of the several formations and the border zone of granitized quartzite were studied.

Profs. Nichols and Stearns led a large group on Saturday to study bedrock geology, glacial geology, and shoreline geomorphology in the area of the north shore from Winthrop and Ipswich. Recently built tombolos near Winthrop, drumlins northeast of Boston, and deposition of flying bars were observed. Peat deposits, older than the present beach deposits, were studied near Revere Beach. Blue Clay deposits, with Greenland fossils, resting beneath beach sands and gravel in some areas, indicated a previously higher stand of the sea. On Nahant, the group examined Cambrian metamorphosed sediments, including diabase sills, folded into synclinal structures and invaded by gabbro.

Another large group, led by Prof. Billings, studied the stratigraphy of the Boston Basin in the vicinity of Nantasket on Sunday. Interbedded basic tuffs and basic flows constituting the north limb of a syncline were examined and conglomerate outcrops on the south limb of the anticline were visited. It was possible to observe that the conglomerates fingered out northward into volcanic rocks. In places, the Roxbury conglomerate rests uncomformably on the Dedham granodiorite and encloses large (6-ft diameter) blocks of the Dedham. The leader pointed out evidence to sustain the thesis that the Roxbury was deposited on a surface of perhaps 500-ft relief in the Nantasket area and 2500 ft in the Hingham area. The evolution of Nantasket Beach was discussed by Nichols, who pointed out wave-cut cliffs now one-quarter mile landward from present sea level.

At the regular business session of the group, held in Barnum Museum, Tufts College, the 1950 field trip was assigned to Joseph Trefethen, head of the Maine University Department of Geology at Orono.

LLOYD W. FISHER

OSA at Buffalo. Optical microscopes and microscopy received major attention at the 34th annual meeting of the Optical Society of America, which was held at the Hotel Statler, Buffalo, New York, on October 27, 28, and 29. Five excellent invited papers were followed by a group of contributed papers on aspects of microscopy, and gave the listeners a very well-rounded picture of the distinguished history, current practice, and new frontiers of this important branch of applied optics.

Leon V. Foster, of the Bausch and Lomb Optical Company, surveyed the steady development of the optical microscope as he has observed it and participated in it during the past 30 years. Harold Osterberg, of the Scientific Instrument Division of the American Optical Company, discussed in a scholarly fashion the somewhat academic subject of microscope imagery and its interpretations, progressing beyond the classical work of Airy and Abbe on the diffraction field resulting from a test object with periodic structure, and suggesting a new criterion for computing the resolving power of a lens. Peter Gray, of the Biology Department of the University of Pittsburgh, spoke on the optical microscope as seen by a user. In a good-humored blast at microscope manufacturers, he pointed out various items which he felt were worthy of improvement in the several standard types of commercial microscopes. It is this reporter's opinion that many of his criticisms were unduly severe and that solutions to his problems are already available, although the rhetorical technique of exaggeration for emphasis is not to be discouraged! John R. Loofbourow, of the Massachusetts Institute of Technology, spoke on the relatively new field of microspectroscopy in which, by a combination of techniques of microscopy and spectroscopy that are almost standard, analyses can be carried out on one-hundredth to one-thousandth the amount of material ordinarily needed—an absorption spectrogram can be obtained from a sample weighing as little as one-millionth of a gram. Among the techniques presently available in this new field are the use of fluorescence spectra, of emission spectra, and of absorption spectra in the ultraviolet, visible, and infrared regions. Receptors other than the photographic plate can be used—for instance, photomultiplier tubes in the ultraviolet and bolometers in the infrared. Single crystals of organic materials can be studied, as can very small sections of tissues, or solutions, by employing special specimen holders or cells. Prof. Loofbourow is interested in the extension of these techniques to the very low temperatures of liquid nitrogen or even of liquid hydrogen or helium. L. Marton, of the National Bureau of Standards, gave a careful comparison and contrast of the capabilities of optical and electron microscopes. Although electron microscopes sometimes achieve the resolution of details as small as 10 angstroms in dimension, they do suffer from several operational disadvantages of a practical nature.

The subject of phase contrast microscopy was dealt with in contributed papers by L. I. Epstein, of Bausch and Lomb, and by F. Zernike, C. P. Saylor, and A. T. Bryce, who suggested employing the great sensitivity of the human eye in hue discrimination in connection with the phase principle in what they called color phase contrast. This is reminiscent of the employment of the eye's color sensitivity in a color translation process for ultraviolet microscopy, which E. H. Land first announced in *Science* early this year (*Science*, April 15, pp. 371–4). Elkan R. Blout, of the Polaroid Corporation, described work under way in the field of infrared microscopy, wherein the apochromatic reflecting microscope objectives designed by David Grey of Polaroid and manufactured by Bausch and Lomb are combined in an ingenious fashion with a standard Perkin-Elmer infrared spectrometer to give infrared spectra of very small samples, such as single hormone crystals or single fibers far too small to be examined with standard infrared instruments.

The field of optics is so broad and has so many different aspects of a theoretical and applied nature, that in a three-day meeting a very large number of subjects are touched upon. Of interest to many were the papers on spectrochemical analysis and those on optical instrumentation techniques, such as new or improved light sources for interferometry, for ultraviolet microscopy, and for infrared spectroscopy; narrow-band interference filters with 80 percent peak transmission; infrared polarizers, which are efficient out to beyond a wavelength of two microns; the use of artificial sapphire in optical elements of complex lens systems; and new fluorescent and phosphorescent phenomena and their application. A. C. S. van Heel, of the Technical University of Delft, Holland, described in an invited paper the methods he developed during and after the war for using extremely simple equipment in making measurements of very high precision. The accurate establishment of angles to less than one-tenth second of arc, the measurement of optical flatness to one-hundredth of a wavelength of light, the alignment of ships' shafts in two dimensions, and the calibration of the vibration magnitude of a church tower when bells are ringing are all subject to handling by these very simple and direct means. In the invited paper which preceded the contributed program on infrared theory and applications, Donald F. Hornig, of Brown University, gave an elegant description of the use of infrared absorption spectra in the study of modes of molecular vibration and of the structure of the solid state. This relatively new technique is proving a powerful supplement to x-ray diffraction in unraveling the secrets of the solid state.

The biologist and the biophysicist found much to interest them at these meetings. George Wald, of the Biological Laboratories of Harvard University, presented a masterly paper which compared and contrasted the eye and the camera. He referred to the three mechanisms for minimizing the chromatic aberration of the eye—namely, the photopic sensitivity shift toward the red from the blue end of the spectrum, where the chromatic error is most troublesome; the strong absorption by the lens of the eye in the near ultraviolet; and the distribution of the yellow carotenoid pigment xanthophyll around the fovea. Dr. Wald recounted the experiments of Kuehne with animal and human eyes in obtaining "optograms," that is, in using the eye as a camera in fact, making on the retina of the eye a picture in terms of bleached and unbleached rhodopsin (visual purple) of an object recently viewed, and he dismissed again that attractive detective story solution wherein the murderer is identified by peering into the eyes of the dead victim. He closed this very interesting lecture by showing a print taken from a gelatin film in which the light-sensitive substance was not silver bromide but rhodopsin extracted from cattle retinas. The subjects of color measurement, color vision deficiency, and other phases of vision and physiological optics were explored in a number of contributed papers. S. Q. Duntley and N. A. Finkelstein, of the Massachusetts Institute of Technology, with Edward A. Edwards, of the Harvard and Tufts Medical Schools, reported on ultraviolet spectral reflectance measurements made on living human skin, and studies of the distribution over the body of ultraviolet-absorbing materials, such as hemoglobin, carotene, and melanin.

George R. Harrison was presented with the Frederic Ives Medal of the Optical Society at the annual dinner, and in his responding speech he sketched the various important stages in his 30 years of spectroscopic research, which started at Stanford University with measurements of the intensity of spectral lines and is now progressing at the Massachusetts Institute of Technology in the modification of one of Michelson's ruling engines for the ruling of a new type of grating called the echelle, which is halfway between a conventional diffraction grating and a reflection echelon. It is Dean Harrison's hope that, by employing careful interferometric control in the ruling of a thousand or so lines spaced a fraction of a millimeter apart, he will be able to achieve the spectroscopist's dream of a resolving power of one million. As a climax to his paper, he showed his audience the first spectrograms taken with an echelle grating.

This meeting marked the end of the two-year term of Rudolf Kingslake, of the Eastman Kodak Company, as the society's president, and his replacement by William F. Meggers, of the National Bureau of Standards.

Your correspondent, who attends both larger and smaller meetings than the one reported upon here, cannot refrain from commenting on the pleasantness and efficiency of a scientific meeting of about this size—a registration of perhaps 500, a total of 50 or 60 papers in three days of sessions, but never more than two sessions proceeding simultaneously and the entire group convening for each invited paper. Let us hope that the Optical Society does not emulate some of its sister societies by becoming so overwhelmingly successful and popular that the size of its meeting is greatly multiplied!

STANLEY S. BALLARD

About People

Carl Barnett Allendoerfer, professor of mathematics at Haverford College, Haverford, Pennsylvania, has been appointed visiting professor of mathematics at Massachusetts Institute of Technology for six months beginning in February, 1950. Dr. Allendoerfer, who has conducted research in the field of differential geometry and the connections between differential geometry and topology, was recently on leave at the Institute for Advanced Study at Princeton.

Vernon L. Mattson, former chief engineer of the Consolidated Feldspar Corporation, Trenton, New Jersey, has been appointed director of the Colorado School of Mines Research Foundation. The foundation, organized early this year, will conduct research in industrial mineralogy.

Benjamin M. Siegel has been appointed head of Cornell University's new Electron Microscopy Laboratory. Before going to Cornell, Dr. Siegel was in charge of the design and construction of a new type of electron microscope at the Research Laboratory of Electronics at Massachusetts Institute of Technology.

X. J. Musacchia, veteran of several arctic biological expeditions, has been appointed to the faculty of the Department of Biology at Saint Louis University. Dr. Musacchia will take part in research experiments in the university's Arctic Research Program.

Philip S. Jastram, formerly instructor in the Physics Department at the University of Michigan, has been appointed assistant professor of physics at Washington University, St. Louis.

William F. Bale, professor of radiation biology at the University of Rochester, has received a leave of absence to act as radiobiologist in the Division of Biology and Medicine of the U. S. Atomic Energy Commission. Dr. Bale will be responsible for the biological and health aspects of the AEC's waste disposal program.

Harry Huger Houston, former vice president of the Brooks Manufacturing Company, Knoxville, Tennessee, has joined the staff of Armour Research Foundation of Illinois Institute of Technology. Dr. Houston will conduct research in the Department of Ceramics and Minerals.

Frederick D. Rossini, chief of the Thermochemistry and Hydrocarbons Section of the National Bureau of Standards, has been appointed professor and head of the Chemistry Department at Carnegie Institute of Technology. The appointment will become effective July 1, 1950.

Visitors

Under sponsorship of the Microbiological Institute, **Sir Philip Manson-Bahr**, of London, will conduct a seminar on "Problems of Filariasis," to be held in Wilson Hall, Administration Building of the National Institutes of Health, Bethesda, Maryland, at 3 p.m. Thursday, December 1. Sir Philip, author of *The dysenteric disorders*, *The life and work of Sir Patrick Manson*, and the 7th to 12th editions of *Manson's tropical diseases*, is in the U. S. on his way to Fiji, where he will join his son in studies of filariasis.

Pablo Kleinman was a recent visitor at the U. S. Geological Survey in Washington. He has been assigned by the Chilean government to study water resource developments in this country. Another caller at the Geological Survey was **R. J. Bocaranda**, of Venezuela, who is interested in ground-water investigations.

Grants and Awards

The National Cancer Institute has awarded Public Health Service grants of $907,212 to aid clinical and laboratory research in nonfederal hospitals and universities in 21 states and the District of Columbia. Fifty-nine awards were renewals. A list of the new grants follows: Stanford University, *E. L. Tatum and A. C. Griffin*, $4,104, nitrogen-mustard carcinogenesis; University of California at Berkeley, *H. M. Evans*, $20,000, relation of the growth hormone to neoplasms; University of Southern California, *D. C. Pease*, $4,536, the electron microscopy of ultrathin tissue sections; Chicago Medical School, *Israel Davidsohn*, $13,198, natural and immune antibodies in inbred mouse strains with low and high tumor incidence; University of Illinois College of Medicine, *A. C. Ivy and Rhoda Grant*, $3,870, a study of the chemical and mechanical factors which may alter the normal growth pattern of the gastric mucosa; University of Southern Illinois, *C. C. Lindegren*, $5,000, genetics of yeast; Indiana University, *E. E. Campaigne*, $1,998, chemotherapy and carcinogens of the carbazole series; Harvard University, *F. J. Stare and R. Olsen*, $6,423, metabolism of tumor tissues; Detroit Institute of Cancer Research, *A. R. T. Denues*, $8,370, fine structure of chromosomes of normal and malignant cells; University of Michigan, *H. M. Pollard*, $5,000, nutritional and blood changes resulting from gastrectomy for gastric carcinoma, and further study of gastric cancer cells, and *A. B. Lerner*, $8,748, investigation of the biochemistry, development, and diagnosis of melanomas; St. Louis University, School of Medicine, *E. A. Doisy*, $4,000, metabolism of radioactive cortisone; University of Missouri, *M. N. Green*, $5,184, the effect of furan derivatives on the metabolism of bacteria and on the growth of transplanted tumors in mice; Albany Medical College, *A. W. Wright and J. M. Wolfe*, $7,344, further study of the etiology of spontaneous mammary tumors in the Albany strain of rats, with particular reference to the possible presence of a milk agent; Brooklyn College, *Irving Kaye*, $6,350, synthesis of N-(2-pyridyl)-substituted-α, β-diphenyl-ethylamines; Columbia University School of Dentistry, *B. M. Levy*, $3,000, a study to determine whether tumors can be experimentally produced in the mouth and lips of animals; Hickrill Chemical Research Foundation, Inc., New York City, *W. von E. Doering*, $10,000, synthesis of colchicine molecule for possible inhibitory cell activity; Memorial Hospital, New York City, *R. W. Rawson and H. J. Tagnon*, $8,910, studies on the inactivation of estrogens and other steroids by liver tissue from cancer patients; Montefiore Hospital, New York City, *E. J. Baumann*, $5,616, selective filtration of the thyroid; University of Rochester, *H. L. Segal*, $4,000, the use of exchange indicator compounds for detecting achlorhydria without intubation; Ohio State University, *H. A. Hoster*, $1,660, studies on Hodgkin's disease and related conditions; University of Cincinnati, College of Medicine, *R. W. Vilter*, $7,895, the culture of human bone marrow in a synthetic medium; The Institute for Cancer Research, Inc., Philadelphia, *G. L. Miller*, $1,296, study of cancer tissue proteins; Wm. H. Singer Memorial Research Laboratory, Pittsburgh, *R. C. Grauer*, $6,350, the influence of various fractions of estrogens on biologic response; University of Pennsylvania, *Charles Breedis*, $5,346, blood supply and drainage of neoplasms in the liver and lung, and *D. W. Wilson and J. M. Buchanan*, $10,800, nucleic acid metabolism; Medical Branch, University of Texas, *G. Sinclair*, $3,240, study of the effects of small amounts of urethane on mice; Medical College of Virginia, *G. Z. Williams*, $7,800, study of purines and pyrimidines in nucleoprotein fractions of precancerous rat livers, and *N. F. Young*, $7,344, influence of certain proteins on the ability of the liver to destroy a carcinogenic agent, *p*-dimethylaminoazobenzene; University of Washington, *R. J. Blandau*, $4,968, study of experimentally produced endometrial polyps in guinea pigs; University of Wisconsin, *Charles Heidelberger*, $4,644, a study of metabolism of carcinogenic hydrocarbons labeled with radioactive carbon; Georgetown University Medical School, *C. F. Geschickter, M. M. Copeland, and Martin Rubin*, $5,000, therapeutic procedures for the retention and redistribution of radioactive phosphorus in patients with malignant disease; and George Washington University School of Medicine, *C. E. Leese*, $6,120, physiological effects of bacterial polysaccharides.

The William H. Nichols Medal of the New York section of the American Chemical Society has been awarded for 1950 to Oskar Wintersteiner, head of the Organic Chemistry Division at the Squibb Institute for Medical Research, New Brunswick, New Jersey. The medal was awarded to Dr. Wintersteiner "in recognition of fundamental contributions to the fields of insulin chemistry, steroid hormones, antibiotics, and alkaloids, and the first isolation in crystalline form of penicillin-G and streptomycin."

The Roscoe B. Jackson Memorial Laboratory for cancer research at Bar Harbor, Maine, received a $15,000 gift recently from the cancer fund of the national women's auxiliary of the Veterans of Foreign Wars. The funds will be used by the laboratory in the rebuilding of its library rooms, which were destroyed in a forest fire in 1947.

The Priz René Leriche of the International Society of Surgery has been awarded to Alfred Blalock, chief surgeon of The Johns Hopkins Hospital. He was honored for his contributions to vascular surgery.

The Sir Henry Wellcome Medal and Prize of the Association of Military Surgeons of the United States was awarded to Elliott Hurwitt for his essay, "A Blood Vessel Bank under Military Conditions," at the association's annual dinner on November 11.

Four grants totaling $15,000 have been awarded the **University of Illinois College of Medicine.** A $10,000 grant from the Pauline E. Reuttinger Memorial Fund will be used by the Department of Pathology for studies in arteriosclerosis by Maurice Lev. The Department of Medicine received two Abbott Laboratories grants, one for $2,500 for a study of dietary therapy in liver disease, and a second of $500 for studies in anesthesia. Smith, Kline and French has made a $2,000 grant for the study of the effect of amines in experimental renal and other experimental hypertensions, to be undertaken by E. A. Ohler in the Department of Physiology.

The Damon Runyon Memorial Fund has presented checks totaling $101,000 to eight institutions for the support of cancer research: New York University-Bellevue Medical Center, University of Rochester School of Medicine, University of Notre Dame, Tulane University School of Medicine, University of Pennsylvania, Rutgers University-Presbyterian Hospital (in New Brunswick and Newark, New Jersey), Harlem Hospital, and the Jewish Hospital in Brooklyn. The memorial fund has allocated nearly $3,000,000 since it was set up in 1947.

Fellowship

A predoctoral research fellowship for the fundamental study of the chemistry of glycerides has been established at the University of Pittsburgh by Armour and Company, Chicago. The fellowship, extending over a period of three years, will be under the supervision of B. F. Daubert, research administrator, Department of Chemistry.

Meetings and Elections

The third annual American Medical Association clinical meeting will be held at the National Guard Armory in Washington, D. C. December 6–9. The meeting will be devoted to the problems of the general practitioner.

The 1949 annual meeting of the **American Physical Society** will be held, for the most part, in the buildings of Columbia University, in New York City, February 2–4, 1950. Titles and abstracts of all contributed papers must reach the APS by *December 9.* Further details can be obtained from Karl K. Darrow, Secretary, American Physical Society, Columbia University, New York 27, N. Y.

A national meeting on histochemistry will be held at the Department of Anatomy, University of Pennsylvania, Philadelphia, on March 25, 1950. Workers in the fields of anatomy, pathology, biochemistry, endocrinology, bacteriology, and other related sciences are invited to attend. Further information can be secured from R. D. Lillie at the Laboratory of Pathology and Pharmacology, National Institutes of Health, Bethesda 14, Maryland.

The Indiana Academy of Science, at its annual fall meeting, elected the following officers for 1950: president, S. S. Visher, Indiana University; vice president, O. B. Christy, Ball State Teacher's College; secretary, W. A. Daily, Eli Lilly and Company; and treasurer, W. P. Morgan, Indiana Central College.

Officers for 1949–50 elected at the annual general meeting of **the Indian Association for the Cultivation of Science** were M. N. Saha, president; C. C. Biswas, first vice president; J. C. Ghose, second vice president; and P. Ray, honorary director.

Deaths

Frank B. Jewett, 70, president of the Bell Telephone Laboratories from 1925 until his retirement in 1940, died November 18, following an emergency operation. Dr. Jewett was responsible for developing the Bell Laboratories into one of the great research institutions of the world. In 1939 he was elected president of the National Academy of Sciences, the first scientist from the industrial field of research to win this distinction. Dr. Jewett was the recipient of many honors and was to have received the Hoover Medal at the January meeting of the American Institute of Electrical Engineers.

Francis E. Randall was killed in the November 1 airplane crash at Washington at the age of 35. Dr. Randall was in charge of research in physical anthropology at the Quartermaster Climatic Research Laboratory, Lawrence, Massachusetts.

Paul G. Heineman, 88, bacteriologist, died November 4 after an extended illness. Dr. Heineman retired as chief bacteriologist of Sterling Drug Company, Cook Laboratories, in 1939. Prior to his service with this company, he had been director of biological laboratories at the U. S. Standard Serum Company.

George Francis Eaton, 77, former curator of osteology and associate curator of vertebrate paleontology at Peabody Museum, Yale University, died at the home of his son in Mystic, Connecticut, on November 6. Dr. Eaton was a member of the Yale Peruvian Expedition to Machu Picchu in 1912.

William J. Humphreys, meteorological physicist at the U. S. Weather Bureau for thirty years, died in Washington on November 10. Dr. Humphreys, who was 87, was professor emeritus at George Washington University at the time of his death.

The U. S. Civil Service Commission has announced an examination for geologists to fill positions paying $3,100 and $3,825 a year in federal agencies, primarily in the Geological Survey and the Bureau of Reclamation, Department of the Interior, in the Bureau of Plant Industry and Soil Conservation Service, Department of Agriculture, and in Corps of Engineers, Department of the Army. Full information is given in announcement No. 199, available at any first- or second-class post office. Applications must be received by December 6, 1949, in the commission's Washington office.

Japanese scientists will soon be receiving isotopes under the foreign distribution program of the Atomic Energy Commission. Surveillance will be maintained by headquarters of the Supreme Commander for the Allied Powers, to assure the isotopes' safe and effective use for work in medicine and biology and research in the physical sciences. Japan is the first occupied country to be admitted to the program. The total number of foreign nations now participating is 30.

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Production of Mesons by X-Rays

Edwin M. McMillan, Jack M. Peterson, and R. Stephen White[1]

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University of California, Berkeley

AT THE 1949 SPRING MEETING of the National Academy of Sciences (*2*) a preliminary account was given of some observations of mesons produced by the 335-Mev x-ray beam from the Berkeley synchrotron. The present paper is a progress report of this work; no claim is made for completeness, but sufficient new data are available to make publication at this time worth while, especially since some of the numerical results given in the earlier report require revision.

The x-ray beam, produced by the impact of 335-Mev electrons on a 20-mil-thick platinum target, has a width at half-maximum of 0.0135 radian (about 1 inch at 6 feet from the target). In all but the earliest experiments the beam was further defined by a 1-inch hole in a lead block, then passed through a piece of carbon, which served as the meson source. The x-ray intensity at one meter from the target was about 3500 roentgens (r) per hour, measured behind ⅛th inch of lead under the best running conditions; the average was about half this. The actual exposures at the carbon meson source (6 feet from the target) ranged from 500 to 2000 r in the later runs. Mesons were recorded on Ilford nuclear plates; the highest density of meson endings observed was about 100 per square centimeter in a 100-micron emulsion. In the following sections the experimental conditions and some of the results are described in more detail.

Plate Exposure. Plates have been exposed in the following ways:

Geometry 1: A stack of plates is traversed directly by the x-ray beam. Mesons are produced chiefly in the glass plates, and exposures are limited by the general blackening due to the beam. Meson tracks are counted in the part of the plates not overexposed by the central core of the beam. There is an appreciable background of photonuclear stars and proton tracks. Only Ilford F-3 plates were used in these exposures.

Geometry 2: The x-ray beam passes through a carbon slab, and the stacks of plates are placed alongside, out of the core of the beam. The intent was to determine the element in which the mesons are produced, but it was found that the wings of the beam had sufficient intensity at the location of the plates to make this somewhat doubtful, considering the fact that there was much more matter in the plates than in the carbon slab used. The background was considerably less than in Geometry 1, and longer exposures could be made; only F-3 plates were used.

Geometry 3: Same as Geometry 2, except that a lead collimator 6 in. thick with a 1-in. hole cuts off the wings of the beam. The x-ray intensity at the plates is now small, and they show little general blackening except along their leading edges; the heavy-particle background is very small. Both F-3 and C-2 plates were used.

Geometry 4: A modification of Geometry 3, with the following changes: A secondary collimator protects the plates from electrons scattered off the edge of the main collimator; the carbon slab is replaced by a cylinder of 1-in. diameter; stacks of plates are arranged radially around this cylinder, with different thicknesses of lead absorbers between the carbon and the plates, as shown in Figs. 1 and 2. Data reported for this geometry were all recorded on C-2 plates.

Types of Meson Tracks. The following types of features are seen at the ends of meson tracks in nuclear emulsions:

(a) Stars of two or more prongs;
(b) Stars of one prong;
(c) μ-meson tracks;
(d) Small "blobs" of a few grains;
(e) Nothing.

Events of type (a) and (c) are obviously recognizable, and require no further discussion. Events of type (d) are not always clearly enough defined to distinguish from (e), and therefore counts of these events cannot be used for statistical purposes, even though they probably represent vestigial stars, being due to the recoils following neutron ejection. In practice, (d) and (e) are lumped together as ρ-mesons.

Particular care is needed in distinguishing events of types (b) and (c) from one another. If the secondary track is heavy, it is clearly a star; if it is light, and of sufficient length to show the characteristic scattering and change in grain density, it is clearly a μ-track. If it is light but leaves the emulsion too

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[1] The authors thank the synchrotron crew for their help in making the exposures and W. S. Gilbert, E. Goodwin, W. J. Knox, G. Maenchen, and F. M. Smith for their assistance in scanning the plates. This work was supported by the Atomic Energy Commission.

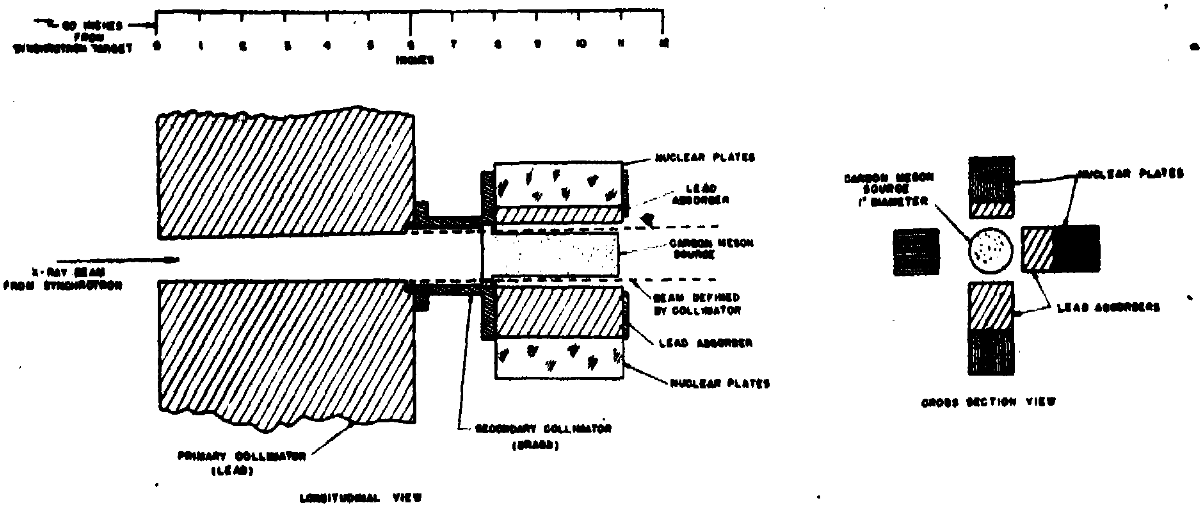
60 INCHES FROM SYNCHROTRON TARGET
0
1
2
3
4
5
6
7
8
9
10
11
12
INCHES
X-RAY BEAM FROM SYNCHROTRON
NUCLEAR PLATES
LEAD ABSORBER
CARBON MESON SOURCE
BEAM DEFINED BY COLLIMATOR
LEAD ABSORBER
NUCLEAR PLATES
SECONDARY COLLIMATOR (BRASS)
PRIMARY COLLIMATOR (LEAD)
LONGITUDINAL VIEW
CARBON MESON SOURCE 1" DIAMETER
NUCLEAR PLATES
LEAD ABSORBERS
CROSS SECTION VIEW

FIG. 1. Drawing of experimental arrangement (Geometry 4).

soon, there is a possibility of confusion. However, examination of magnetically sorted negative mesons produced in the cyclotron and recorded on Ilford C-2 plates shows that light single-pronged star tracks are almost invariably accompanied by blobs resulting from the recoil consequent on the emission of a very fast proton. Therefore, single light secondary tracks with no blobs are recorded as μ-tracks, even though the observed range may not be long enough for positive identification.

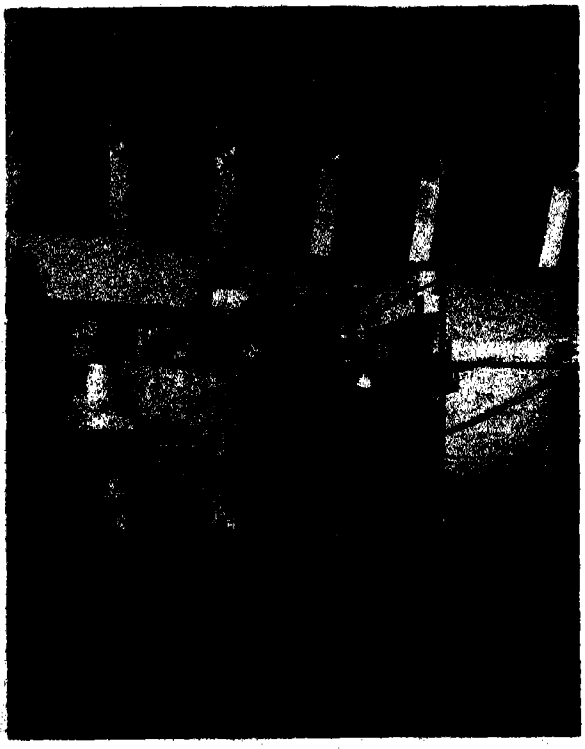

FIG. 2. Photograph of experimental arrangement (Geometry 4). The x-ray beam emerges from the synchrotron through the rectangular hole (A). The 6-inch-thick lead collimator is at B. C is the plate holder.

We finally arrive at three classifications of meson track endings:

(a) + (b), denoted by σ

(c), denoted by $\pi\mu$

(d) + (e), denoted by ρ.

It is desired to compute from these the numbers of negative and positive π-mesons (π^- and π^+) stopping in the emulsion.

Methods of Computation. (a) Computation of π^-. Negative π-mesons are assumed to be captured in the emulsion, and may or may not make recognizable stars. Therefore, it is important to know the fraction of cases in which stars are produced. Data on this are available from counts of tracks in Ilford C-2 plates due to magnetically sorted negative mesons (*1*). In these plates, it was found that the ratio $\rho/(\sigma + \rho) = 0.27$; we deduce that, in Ilford C-2 plates, $\pi^- = 1.37\ \sigma$. (b) Computation of π^+. *Method A.* If the plates are sufficiently sensitive to show the early parts of μ-tracks with certainty, then the number $\pi\mu$ is essentially equal to π^+. Experiments with magnetically sorted positive mesons (*3*) show that in C-2 plates at least 95 percent give recognizable π-μ decay. Therefore, when using these plates, it is assumed that $\pi^+ = \pi\mu$. The number ρ does not enter into this computation. *Method B.* If, on the other hand, less sensitive plates are used, as for example Ilford F-3, it is harder to recognize the μ-tracks and a considerable fraction of them may be missed. Then a different method must be used, which is based on the assumption that all tracks not associated with negative π mesons, i.e., a number equal to $\sigma + \pi\mu + \rho - 1.37\ \sigma$, consist of π^+ tracks plus an equal number of μ tracks. The distinction between $\pi\mu$ and ρ does not enter into this calculation. This method may underestimate the true number, since the μ-particles are emitted in random directions in the emulsion and glass of the plates, and therefore a certain fraction of these will end while crossing the emulsion at unfavorable angles for identification, while the π-particles are traveling approximately parallel to the emulsion. Without attempting to correct for this, the Method B calculation assumes that:

$$\pi^+ = (\tfrac{1}{2})(\sigma + \pi\mu + \rho - 1.37\,\sigma).$$

Results. π^-/π^+ *ratio.* At the time of writing the abstract for the National Academy meeting (*2*) 145 tracks were available, of which 51 were from Geometry 1 and 94 from Geometry 2. All of these were on F-3 plates, and therefore only Method B could be used for the computation, giving the published ratio $\pi^-/\pi^+ = 10$. By the time of the meeting, more tracks were available, including some on Geometry 3. The Geometry 1 tracks were then discarded, since they represent mesons starting in glass rather than carbon. The new total of 198 tracks (103 on Geometry 2 and 95 on Geometry 3), mostly on F-3 plates and analyzed by Method B, gave $\pi^-/\pi^+ = 7.5$, which was the value reported verbally at the meeting.

Since then, more tracks have become available, and it is now possible to give data obtained entirely with Geometry 4, using C-2 plates, and analyzed by Method A. Blank runs, with no carbon target in place, prove that virtually all the mesons seen actually originate in the carbon. In this setup there are plates behind lead absorbers, on which mesons of higher energy are recorded. The energy ranges are assumed to be defined by the stopping power of the absorber (including the radius of the carbon cylinder) for one limit, and that of the absorber plus the plate width for the other. No obliquity correction was applied. The values found for the ratio π^-/π^+ in the various energy bands, covering a range from about 30 to 150 Mev, agree within the statistical errors, which are about ±25 percent for bands about 10 Mev wide below 100 Mev, and ±50 percent for a band between 100 and 150 Mev. Since there is no statistically significant evidence for a variation with meson energy, the data are lumped together, including only track counts made or checked by experienced observers. These counts are: $\sigma = 403$, $\pi\mu = 327$, $\rho = 323$. Using Method A, the ratio $\pi^-/\pi^+ = 1.7$, with a statistical standard error of 8 percent. Method B applied to the same data gives $\pi^-/\pi^+ = 2.2$, indicating the sort of error to be expected when the latter is used with C-2 plates; it may be still greater with F-3 plates, on which the tracks are harder to find. It will be noted that this ratio is less than the previously given values. The difference from the earlier values may be partly real, that is, the Coulomb effect for very low energy mesons made in glass may distort the ratio somewhat; a considerable part of the difference certainly comes from the errors inherent in the use of Method B with F-3 plates, and some may be attributed to inexperience of the observers in the beginning.

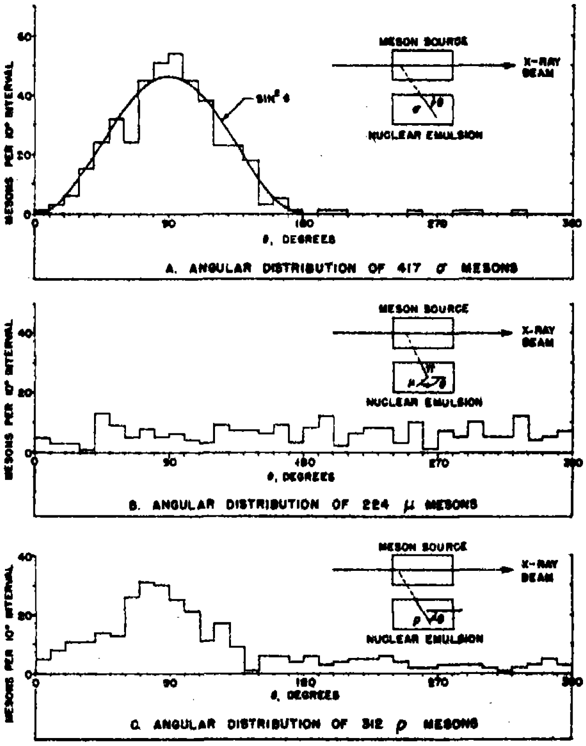

FIG. 3. Angular distributions of meson tracks in the energy range 48 to 59 Mev. (A) σ-Mesons. The curve $\sin^2\theta$ represents approximately the distribution to be expected in case of spherically symmetrical emission from all parts of the carbon target. The few tracks in the range 180° to 360° were probably scattered. π-Mesons associated with $\pi\mu$-decay give a similar distribution. (B) μ-*Mesons* associated with $\pi\mu$-decay. There is no evidence here of departure from spherical symmetry. (C) ρ-*Mesons*. This distribution is clearly composite, the peak at 90° being due to π^- mesons that fail to make visible stars, while the uniform background is due to μ-mesons.

The ratio of 1.7 does not pose the formidable theoretical problem offered by the earlier value; in fact a ratio of this order can be explained on rather elementary grounds. Consider the products of the reactions, which are π^- and π^+ in one case, and π^+ and n^0 in the other. The current accompanying the process is greater in the former because of the contribution of the recoil proton, and therefore the coupling to the photon field is larger. This effect, which increases with meson energy, plus the Coulomb effect on the meson wave function, which decreases with energy, together can account for the observed ratio. A detailed discussion of this will be given in a later publication by K. A. Brueckner.

Yield of Mesons. Energy and Angle Distributions. From the data obtained with Geometry 4, some information can be gained on the distribution of mesons in angle and energy, as well as the total yield. The distribution of angles of the straight parts of the tracks (excluding of course μ and ρ tracks) is consistent with that to be expected for an isotropic emission from all parts of the carbon target. The computed distribution on this assumption, in the case of the plates covering the band 43 to 59 Mev, can be represented approximately by $\sin^2 \theta$. Fig. 3A shows that the data agree with this. Higher energy plates show the expected narrower distribution, and lower energy plates a slightly wider one. The conclusion is that the initial meson distribution has at least roughly spherical symmetry. In order to compute the total number of mesons in a given energy range, we then use the fact that an ideal infinite line source would give a uniform angular distribution, whose height would be equal to the observed height at 90°. The height is computed by fitting the expected shape to the observed distribution—or, what is the same thing, the total number is taken to be the observed number multiplied by a "shape factor," which is just 2 in the case of the $\sin^2 \theta$ distribution.

The differential yield $\frac{dN}{dE}$ can now be computed from the following formula:

$$\frac{dN}{dE} = 4\,r\,\frac{dR}{dE}\,\frac{1.37\,\sigma + \pi\mu}{At} \times \text{shape factor},$$

where N = No. of mesons produced per cm length of target
E = energy of mesons
r = radius to center of area scanned
R = range of mesons in glass or emulsion (these are nearly equal)
σ, $\pi\mu$ are track counts in area A of emulsion
t = thickness of emulsion during exposure (a shrinkage factor of 2.4 was used).

The shape factor varies from 1.8 to 4.3.
The results, normalized to an exposure of 1 r, are given in Fig. 4, with standard errors from the track counting statistics alone. The most likely other errors are losses at the low energy end from self-absorption in the carbon, and at the high energy end from scattering in the lead absorbers.

The absolute value of the cross section can be obtained from the integral of Fig. 4, if the number of quanta corresponding to the rather arbitrary unit "r behind $\frac{1}{8}$th inch of Pb" is known. This has been measured, using a thin air chamber intercepting the whole beam as defined by the collimator, with thin layers of

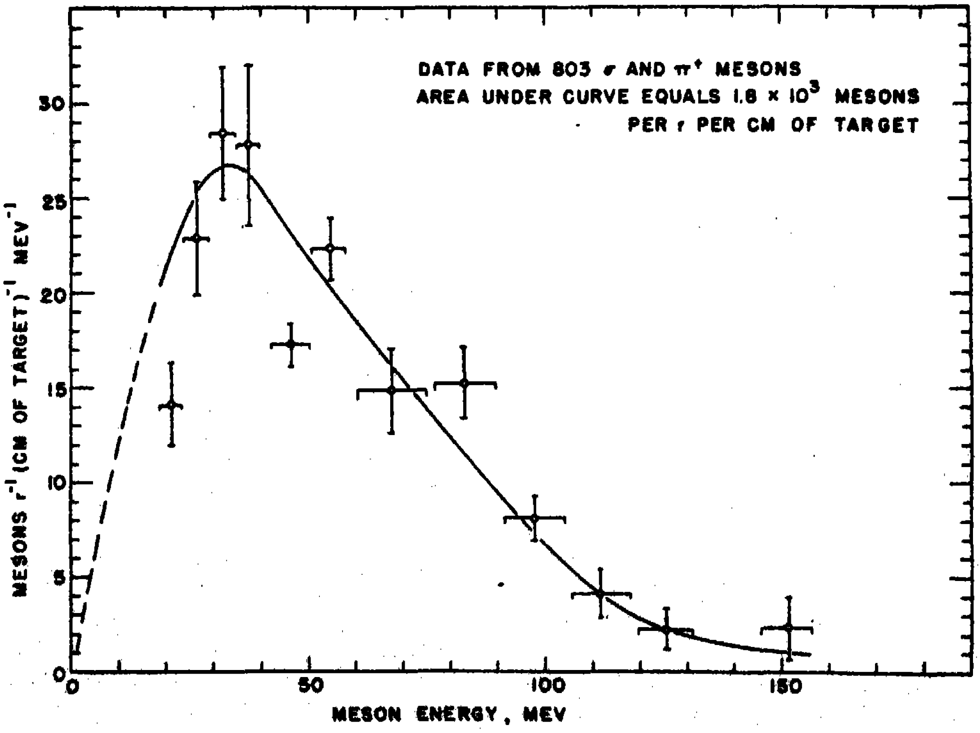

FIG. 4. Distribution of meson energies from x-ray energy of 335 Mev. The apparent lower limit on the energy is caused by the fact that the energies are computed as if the mesons originated in the center of the carbon block. The dotted line is simply a guess as to the trend of the distribution at low energies, which was used in the integration leading to the total cross section.

lead and other substances in front in order to be able to estimate the amount of the ionization due to pair production alone. This will be described in detail in a later publication; the result was that 1 r on the carbon corresponds to 4.9×10^7 quanta traversing it, where the number of quanta is defined as the total x-ray energy divided by the upper limit energy. (The actual number of quanta in a range between E_1 and E_2 is approximately $ln\ (E_2/E_1)$ times the above number.) The total cross section per quantum per carbon nucleus is then found to be 5×10^{-28} cm^2. It is hard to make an estimate of the over-all accuracy of this figure, but it is probably not wrong by more than a factor of 2. The difference between this value and that given in reference *2* is easy to understand, since the latter, made from Geometry 1 plates, included only very low energy mesons. One run was made at an x-ray energy of 200 Mev; here the meson energy distribution extends only to about 35 Mev, and the yield is considerably less than at 335 Mev. Because of the large self-absorption of the mesons at this energy, no attempt was made to calculate a cross section.

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Experimental Control in Hypnotic Age Regression States

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THE RECOVERY OF EARLY CHILDHOOD MEMORIES, lost through the ordinary processes of forgetting or because of subconscious repression, has a definite place in modern psychotherapy. The importance of catharsis has long been recognized, but too little work has been carried out to determine whether hypnotic age regression is a fact, or, as Young (*4*) believes, an artifact. Too few adequately controlled experiments have been carried out which separate and distinguish between half-conscious dramatization of current memories of a previous time and actual revivification of behavior patterns of a suggested earlier period of life in terms of what actually belongs there. Since both conditions may exist during a sitting, the importance of constant control cannot be overemphasized. Erickson and Kubie (*1*) recognized the existence of these two states and yet utilized hypnotic age regression with a great deal of success in the treatment of hysteria without determining which state was involved. The fact that psychotherapy based upon a supposed memory is of value to a patient is hardly satisfactory evidence of a true regression, since it is always possible that a pseudomemory may be effective in such a case (*3*). This has been shown quite conclusively in the use of play or dramatic therapy, both in the waking state and during hypnosis.

Information from relatives, verbal material memorized at an early age, and diaries are unsatisfactory controls, since the normal processes of forgetting must be considered in the first case, the possibility of review in the second, and the recognized inaccuracy of diaries written at an early age in the last case. The factor of the recall of very recently learned material may be of value from an academic viewpoint but is obviously unsatisfactory for hypnoanalytical purposes, where remote memories are of primary importance.

For the most part, the use of hypnosis in age regression has been interpreted in terms of a hypothetical state called *dissociation*. Psychoanalysis and hypnoanalysis are actually doctor-patient battles, with the patient trying to retain his compulsions and the operator equally determined to eliminate them. The evidence points at the fact that the recall of actual traumatic experience is more efficacious in bringing about beneficial results in the treatment of a neurosis than the reliving of an imagined experience (*2*), although it must be recognized that neither one invariably brings about the desired therapeutic change.

It is easy to see the importance of certain controls in determining whether or not actual age regression has occurred. The writer has devised a method of control which has proved effective in 82.3 percent of a mixed group, as shown in Table 1. Before induction, subjects were asked to state the day of the week during which certain relatively recent events had occurred. An extremely small percentage gave correct answers to any of the questions, leading one to believe that when correct answers were given they were largely owing to chance. After hypnotic induction, subjects were subjected to the usual tests for depth of hypnosis, such as the induction of positive and negative hallucinations, analgesia, and the inhalation of ammonium hydroxide (with the suggestion of inhalation of a pleasant perfume). They were then regressed year by year, using memorable dates as chronological landmarks. On such dates they were asked, "What day is this?" and their answers were scored against a 200-year calendar. Of the mixed group of 40 men and 10 women 82.3 percent gave entirely accurate answers to these questions, while the remaining 17.7 percent answered less than half the questions correctly. The inaccurate answers might well be explained by individual differences in retentiveness through developmental years or by the fact that this small group of people were dramatizing memories in the light of their present beliefs. It should be noted that all members of the test group had previously been regressed to at least the age of 5 prior to the sessions in which they were subjected to control. All were excellent somnambules and had been chosen from a group of 175 as being the best subjects. All questions asked were simple and direct. Subjects were merely asked on what days of the week Christmas and their birthdays fell in the particular years involved and were scored on the basis of regression to ages 10, 7, and 4.

TABLE 1

HYPNOTIC AGE REGRESSION STATES OF 50 SUBJECTS
(40 MALES, 10 FEMALES; AGES 20–24)

	No. of subjects	Percentages	Male	Female
Age 10				
Birthday:				
Correct answer	46	92	37	9
Incorrect answer	4	8	3	1
Christmas:				
Correct answer	47	94	37	10
Incorrect answer	3	6	3	0
Age 7				
Birthday:				
Correct answer	42	84	36	6
Incorrect answer	8	16	4	4
Christmas:				
Correct answer	40	86	34	6
Incorrect answer	10	14	6	4
Age 4				
Birthday:				
Correct answer	31	62	24	7
Incorrect answer	19	38	16	3
Christmas:				
Correct answer	38	76	31	7
Incorrect answer	12	24	9	3

A method of control of this sort is much easier to handle than some of the more involved techniques utilizing electroencephalography and the thematic apperception test, its simplicity making it more practicable clinically.

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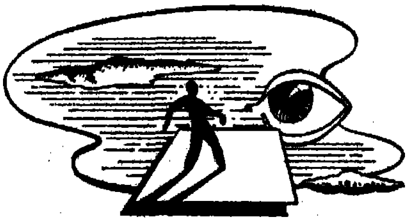

TECHNICAL PAPERS

A Preliminary Report on the Study of the Relationship of Psychosomatics to Oral Conditions—Relationship of Personality to Dental Caries

John H. Manhold[1] **and Vivian W. Manhold**[2]

Tufts College Dental School, Boston

The influence of psychosomatic factors on bodily disorders has been established by the correlation found between clinical and psychological data. Such pathological conditions as duodenal ulcer (*1, 27*), mucous colitis (*20, 25*), asthma (*5, 9, 10*), chronic rheumatism and rheumatoid arthritis (*12*), and thyroid disorders (*8, 13, 17*), have been shown to have psychogenic factors. Many assumptions have been made that oral conditions may also have a psychosomatic basis (*6, 11*). Sometimes these assumptions are based upon chemical tests of blood and saliva of institutionalized subjects (*15, 24, 26*), and more often merely upon clinical observations (*18, 19*). In no instance has there been statistical proof of a correlation between oral conditions and psychogenic factors. This study was initiated to discover whether such a correlation exists among persons who would be classified as normal from the psychiatric standpoint.

TYPE OF SUBJECTS	NUMBER OF SUBJECTS	NEUROTIC TENDENCIES VS. D.M.F. SCORE	INTROVERSION EXTROVERSION VS. D.M.F. SCORE	SIGNIFICANCE LEVEL 5%	1%
MEN	25	+.446	+.405	.388	.496
WOMEN	25	+.463	+.447	.388	.496
MEN AND WOMEN	50	+.474	+.443	.276	.356

FIG. 1. Correlation coefficients.

The Personality Inventory of Robert G. Bernreuter (*2*), and a modified D.M.F. (decayed, missing, filled) scale (*14, 21*) were employed as systems of measurement. Bernreuter's Personality Inventory is advantageous for our purposes in that it permits the measurement of several different traits of personality at one time without allowing the nature of the qualities under study to be readily discernible either by the examiner or by the person examined. It purports to measure neurotic tendency, self-sufficiency, introversion-extroversion, dominance-submission, confidence in one's self, and sociability. On our first 21 subjects, the inventory was scored for all six traits, but we discontinued scoring for all as soon as we discovered that only two traits, introversion-extroversion and neurotic tendency, were highly correlated with a dental condition. Snyder tests (*22, 23*) for acidophilus bacilli were also run on the first 21 cases, but did not correlate with any Bernreuter traits. The high correlations were between D.M.F. and the two traits mentioned.

Therefore, we proceeded to increase the number of subjects to 50, equally divided as to sex. All subjects were faculty, students, or employees of Tufts College Dental School. The age, sex, and education of each person was recorded, but names were omitted in order to increase our expectation of obtaining truthful answers to the questions. The subjects were charted for the number of caries, fillings, and missing teeth. Each surface of a tooth containing caries or a filling was scored as one point. Extracted teeth were scored as 3 points in accordance with the Bodecker system (*3, 4*), and Marshall-Day's A.C.F. (average caries frequency) ratings (*7, 16*). Decay around fillings was not counted unless it involved new surfaces, for such decay is usually considered to result from faulty restorations.

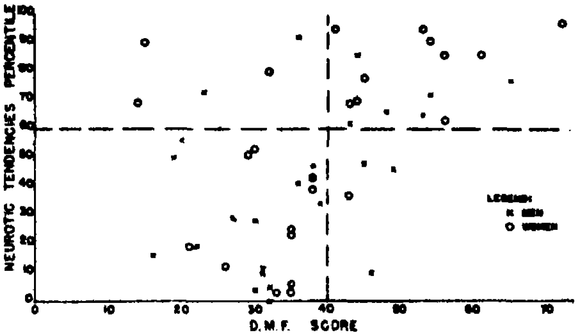

FIG. 2. Neurotic tendencies percentile vs. D.M.F. score.

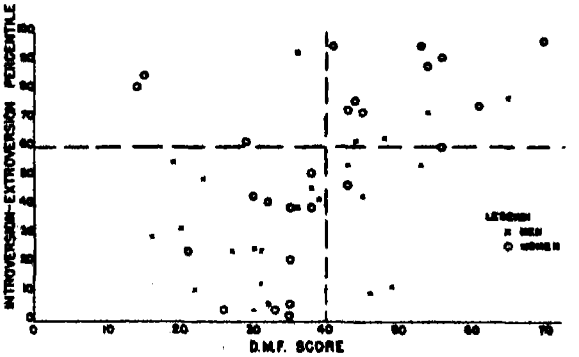

FIG. 3. Introversion-extroversion percentile vs. D.M.F. score.

The D.M.F. score was then placed on the outside sheet of each Bernreuter test, and the tests were scored for introversion-extroversion and neurotic tendencies. Scoring was done with Bernreuter standard scoring sheets and percentiles were then found on the standardized scale.

The results are presented in Figs. 1–4. All but four of the subjects who were well below the lowest levels of neurotic tendencies (60 percentile and slightly below) had gained less than a 40 D.M.F. score, while those who were above these limits had, with but five exceptions, gained a D.M.F. score higher than this. The results obtained on the introversion-extroversion scoring showed that all but six of the subjects who were well within the normal limits had gained fewer than 40 points, and all but four above this limit had scored higher than 40.

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[2] Psychometrist Counseling Service, Y.M.C.A.

The correlation coefficient for neurotic tendency percentile and D.M.F. points in men was + 0.446, and for introversion-extroversion and D.M.F. points the coefficient was + 0.405. These correlations are significant at the 5% level of confidence.

The coefficient of correlation between neurotic tendency percentile and D.M.F. points in women was + 0.463, and the introversion-extroversion coefficient was + 0.447 which is also significant at the 5% level.

TYPE OF SUBJECTS	NUMBER OF SUBJECTS	NEUROTIC TENDENCIES	INTROVERSION EXTROVERSION
MEN	25	7.8	5.3
WOMEN	25	11.9	11.9
MEN AND WOMEN	50	19.8	10.9

SIGNIFICANCE
$\chi^2 > 3.84$

FIG. 4. Chi square values.

The combined correlation coefficients for the total 50 subjects were n_e + 0.474 and i-e_e + 0.443. These are significant at the 1% level.

Another method of testing the realtionship just shown is the chi square test, which was applied with the following tabulated results.

Since all of these results are well above the required 3.84, the data obviously have statistical significance. The mean results indicate that there is less than 1% possibility that the results might be owing to chance distribution.

The Bernreuter Personality Inventory is not necessarily an exact measurement of personality, but is today the best and most valid test of its kind to measure traits of personality as divorced from intelligence. Furthermore, the important fact is not so much that specific personality traits are measured, but rather that a correlation between some traits and oral conditions exists. The D.M.F. scales which we are forced to use are also not the final answer to the measurement of caries incidence, but again are the most valid we have at our command. Added to this, we have a good indication that the value of the correlation coefficient will prove to be above + 0.40 if further studies are undertaken. This is surprisingly high if one realizes that the best correlations between medical disorders and psychic factors are rarely higher than + 0.50. It appears that the correlation between psychological factors and oral conditions merits further investigation with different types and larger numbers of subjects.

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A Preliminary Report on Histochemography[1, 2]

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During the summer of 1948, it was observed that normal rat bone marrow diluted with clear dog serum blackened an Eastman NTB photographic plate when smeared directly on the emulsion surface and stored at approximately − 15° C for several days. This observation was made on control experiments during an attempt to obtain single bone marrow cell autoradiographs.

Fig. 1 is a dark-field photomicrograph showing individual silver grains after development. The grains are

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[1] A histochemograph is defined as a gross picture on a photographic plate or, at high magnification, a pattern of silver grains produced by the chemical action of a histological specimen in direct contact with the emulsion of the plate.

[2] This paper is based on work performed under contract with the U. S. Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York, and supported in part by the National Advisory Cancer Council of the U. S. Public Health Service.

grouped beneath cells[a] in some cases, but other groups are unassociated with cells. Examination of the gelatin of the emulsion indicated that the spots unassociated with cells did not represent sites where cells had been washed away in the photographic fixing process, as was first suspected. The cause of the spots is unknown.

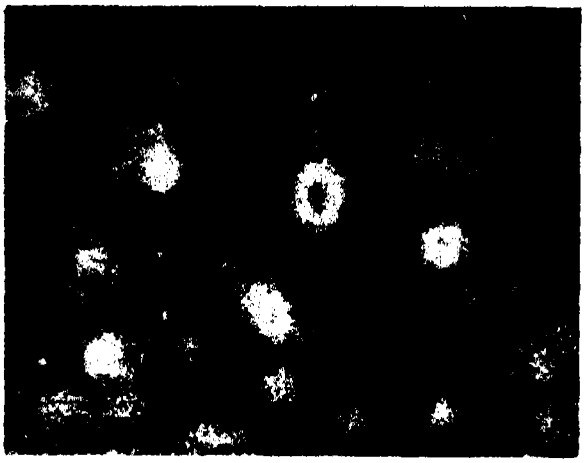

FIG. 1. A dark-field photomicrograph of a chemograph produced when rat bone marrow, diluted with dog serum, was smeared on an Eastman NTB photographic plate. Magnification approximately 666 ×. Some groups of silver grains are in the emulsion beneath a single cell and extending for *several μ in all directions beyond the edge of the cell.* This is illustrated by a bright spot (black spot in the original) with a dark spot in the center, the dark spot being the cell which has absorbed the scattered light from the grains beneath. Other bright spots show no cells present.

Peripheral blood from the same rat diluted with the same dog serum did not blacken the plate. The exposures continued for as long as 67 days. All plates developed serially showed that the bone marrow blackening increased in intensity with time while the peripheral blood smears showed no blackening, as can be seen from the background of the photographs published earlier in *Science* (*1*).

This emphasized the long-suspected likelihood of histochemical fogging and possible misinterpretation of autoradiographs from unfixed tissues. It was considered prudent to publish the results of preliminary experiments to bring this danger to the attention of those making autoradiographs.

A series of NTB plates were exposed to peripheral blood, spleen, kidney, liver, heart, and lung of a normal rat, sacrificed in the darkroom under a red light, Wratten Series I. A drop of blood was released from the jugular vein onto the emulsion and was not smeared. Slices of fresh organs were cut with a razor blade at 3–5-mm thickness and placed in direct contact with the emulsion. The tissues were on the emulsion at room temperature for 10–40 min, after which time they were stored at approximately −15° C to prevent further autolysis.

The plates were removed serially in time. After warming the plates to room temperature and removing the organ slices with soaking in water, we developed them in dilute Eastman Kodak D19 (1 part D19 to 3 parts water) for 25 min. Photographic densitometer measurements were made. In general, the density increased with time. It is interesting that the blood, placed as a drop on the emulsion, showed a small amount of blackening in about 2 weeks, whereas the blood of the first rat, in the summer of 1948, when diluted with dog serum and smeared on the emulsion, showed no blackening after 67 days.

Some of the exposures showed patterns which, it was felt, corresponded to the architecture of the section surface. Fig. 2, a chemograph of a kidney cross section, shows striations and other patterns, which may have been produced by tubules or blood vessels in the cortex, and shows a reticular pattern in the medulla, although not evident in the illustration. This reticular pattern is composed of discrete lines 4–8 μ wide, intersecting to form tiny unexposed areas of varying size. These were observed to be coincident in position with the interstitial connective tissue or basement membrane of the medullary epithelium. In the cross section of the liver, the lobule parenchyma was indicated by heavy blackening and portal areas by lighter blackening of the emulsion.

The experiment was repeated with two variations: (1) the age of the rat was approximately 250 days as contrasted with 90 days for the rat of the first experiment; and (2) immediately upon removal of the organ from the rat, it was placed on dry ice and remained frozen during sectioning, placing on the emulsion, and storage until removal for development. The same patterns of blackening were obtained as in the first experiment, with the exception of the high reticular resolution in the kidney.

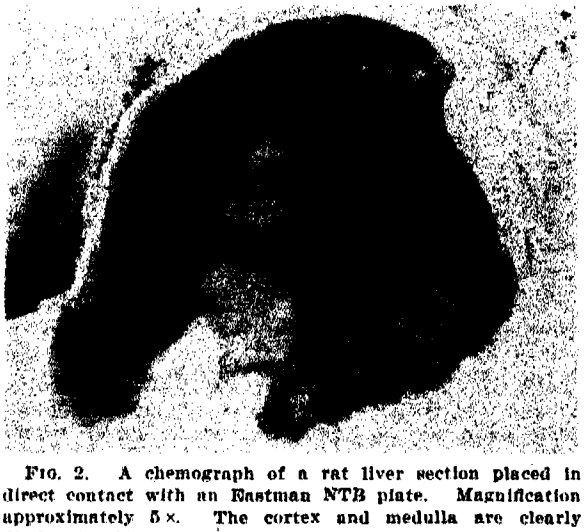

FIG. 2. A chemograph of a rat liver section placed in direct contact with an Eastman NTB plate. Magnification approximately 5 ×. The cortex and medulla are clearly distinguishable.

Recently, a desensitizing effect was observed when the spinal cord of a cat was placed in contact with an NTB emulsion surface for less than 30 sec, and the entire slide exposed to light from an overhead incandescent lamp for less than 1 sec. The entire plate except that part in contact with the cord was black after development. The area in contact with the cord was composed of two parts. One was completely transparent, indicating complete desensitization of the emulsion to light, and was structurally associated with white matter. The other was very slightly blackened and was structurally associated with gray matter.

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[a] Because of the difficulty in properly staining the cells after passage through photographic developer and fixative, various observers could not agree on the identification of the cells; but it seems probable that those showing the greatest blackening were the earlier forms of the erythrocyte series.

While we felt the blackening had been produced by direct chemical action, the possibility of blackening by photons produced in the fresh tissue could not be overlooked. It is well known that histological tissues produce photons by fluorescence after exposure to ultraviolet light. Usually fluorescence is produced only by ultraviolet light, is short-lived, and the number of photons is relatively large. In principle, however, there could be some compounds in the tissues which might be raised to a higher energy level by any portion of the spectrum and produce a delayed emission of a small number of photons. If this were so the photographic plate would integrate the effect over a long exposure, making observable a phenomenon unobservable instantaneously by the eye. There was also the possibility of a small number of photons from oxidative processes. Even though these possibilities seemed remote they were investigated in a preliminary manner.

TABLE 1

RESULTS OF A TEST FOR PHOTONS PRODUCED BY A TISSUE AS DETECTED BY AN EASTMAN NTB EMULSION

	Tissue and emulsion separated by quartz slide		Tissue and emulsion in contact	
	Control not exposed	Exposed to ultraviolet light 5 min	Control not exposed	Exposed to ultraviolet light 5 min
2 hr	No image	No image	Image present, photographic density .07	Image present, photographic density .06
24 hr	No image	No image	Image present, photographic density .14	Image present, photographic density .18

Two series of experiments were carried out in which kidney and liver slices were separated from the photographic emulsion by (1) a glass cover slip and (2) quartz plates approximately 1 mm thick. In this experiment the animal, a rat, was dissected in the lighted room. After a 2-week exposure of the slices in the deep freeze, no image was observed.

In a repeat experiment using the kidney, a guinea pig was sacrificed in total darkness. Tissue slices exposed to ultraviolet light for 5 min and slices left in darkness were placed side by side on a quartz plate, which in turn was placed on an NTB plate. A similar set was placed in direct contact with emulsion of an NTB plate. The time from the end of ultraviolet exposure to placing on the photographic plates was about 3 min. The quartz plate was 1 mm thick. The results are given in Table 1.

After both 2- and 24-hr exposures at approximately − 15° C, no image was found under the sections on the quartz plate. This indicates that the kidney picture shown in Fig. 2 was not produced by photons of fluorescence, oxidative luminescence, or any form of biochemical photon production in the range of wavelengths transmitted by the quartz and recorded by the NTB emulsion.

The experiments on direct contact, showing approximately equal densities for the tissues exposed and unexposed to ultraviolet light, for both 2 and 24 hr, indicate that there was no delayed emission of photons produced in the companion experiment and filtered out by the quartz. The interesting well-known observation of yellow fluorescence was seen on irradiation, but died out within a few seconds after the ultraviolet source was turned off.

As many of the autoradiographs made in this laboratory are fixed in Bouin's solution, experiments were run to test the possibility of artifacts from this source. Paraffin sections of rat lung, heart, kidney, and liver, which had been fixed in Bouin's solution, were placed in direct contact with an NTB plate. No blackening was observed after several weeks of exposure at approximately − 15° C.

These preliminary experiments indicate that Figs. 1 and 2 were produced by direct chemical action. It should not be inferred that these observations prove the nonexistence of biochemically produced photons. Emulsions of different sensitivity or biological tissues under different conditions might show the production of a small amount of photons.

These results on NTB emulsions can be taken only as a warning when working with other emulsions. It does not follow that lantern slides or x-ray emulsions will show the same pattern or intensities. They may give the same or different patterns and may be more or less intense. For example, it is well known that hydrogen peroxide will fog many photographic emulsions (*3*), but it does not fog NTB emulsions. Also, the effect of histological fixative solutions and stains should be checked until proved harmless.

One advantage of the NTB plate, especially the NTB 2, or electron track plate, is that autographs can be differentiated from chemical fogging by virtue of the tracks for autographs and random grains for chemical fogging.

These observations suggest a new histochemical tool. The NTB plate with its low background fog and small grain size giving high resolution, is probably the best for this purpose, though other plates have not yet been tested.

It should not be inferred that this artifact makes autoradiography impossible. It does, however, emphasize the necessity of running controls on all solutions and tissues coming in contact with the emulsion. Another means of eliminating the artifact is by interposing a thin impermeable film between the subject of study and the emulsion. Stripping film is one type of emulsion designed for this purpose (*2*).

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Some Observations on the Role of Folic Acid in Utilization of Homocystine by the Rat[1]

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Rats bred in this laboratory on our preexperimental diet, which has been described in detail (*1, 4*), have been shown to grow on a diet containing homocystine as the sole source of sulfur-containing amino acids, without known sources of labile methyl donors. The importance of the preexperimental diet for this phenomenon has been emphasized (*1*) and the possibility of stored factors involved in the utilization of homocystine suggested.

In subsequent studies, Sulfasuxidine was administered to rats under the same experimental conditions, on the assumption that the possible source of labile methyl donors could have originated from intestinal bacterial synthesis. This drug is known to be an inhibitor of intestinal synthesis of biotin and folic acid. The ability of the rats to utilize homocystine seemed to have been lost in conjunction with the destruction of the intestinal flora responsible for synthesis of folic acid, for growth could not be reestablished by dietary supplements of extra biotin and of folic acid concentrate or ryzamin-B (*2, 5*). This fact suggested that the bacteria synthesize a factor involved in the utilization of homocystine. However, the ability of the rats to utilize homocystine for growth could be reestablished with continued feeding of the sulfonamide by further supplementation of the diet with Liver Extract Lilly (LEL). These results could be interpreted as indicating that LEL furnishes to the rats factors made unavailable by the Sulfasuxidine. Since crystalline folic acid had become available, it seemed desirable to add it to the vitamin supplement to ensure adequate replacement of at least two vitamins involved, biotin and folic acid. The present report is concerned with the role of folic acid in the promotion of growth of rats on a labile methyl donor-free diet, containing homocystine as the sole sulfur amino acid, in the presence and absence of Sulfasuxidine.

The experimental procedure has been outlined in earlier publications (*3–5*). Table 1 gives a summary of the results obtained. The rats fed the Sulfasuxidine diet had received the basal diet approximately 50 days before the initial period reported in the table. Rats 34–37, littermates, show the best response to folic acid obtained under these conditions. The initial weight of the rats was 90.5, 80.5, 69.0, and 73.0 g, respectively; the average gain per day was 1.2, 0.9, 1.4, and 1.5 g. The growth response varies, however, in different individuals, and data for rat 62 are presented as an example of those animals that do not respond to folic acid even though growth is elicited in them by LEL. Still other rats, not reported here, showed intermediate degrees of growth.

The rats which did not receive the sulfa drug had been fed the basal diet approximately 34 days before the initial period reported in the table. When taken from the colony diet, at 36 days of age, the animals were depleted on the basal diet, without homocystine, for 14 days. Then on addition of homocystine they were allowed to regain their initial weight before the 26-day period reported; this took about 20 days. However, the rats received the extra biotin and folic acid from the beginning of the experimental period. The initial weight of the rats was 118.5, 119.0, 98.0, and 103.0 g, respectively; the average gain per day was 1.5, 1.7, 1.0, and 1.7 g.

TABLE 1

EFFECT OF FOLIC ACID ON THE GROWTH OF RATS FED A LABILE METHYL-FREE DIET CONTAINING HOMOCYSTINE WITH AND WITHOUT ADDITION OF SULFASUXIDINE

Rat Nos. ♀	Diet	Days on diet	Food intake per day in g	Initial weight in g	Total gain in g	Gain per day in g
	(With 2% Sulfasuxidine)					
	Basal*	12	2.0	78.3	− 3.3	− 0.3
34–37†	Basal + Ry‡ + Bi§	12	2.5	75.0	0.3	0.0
Avg (4)	Basal + Ry + Bi + Fo‖	28	4.2	75.3	34.9	1.3
	Basal + Ry + Bi	18	4.0	110.1	6.0	0.3
	Basal	12	1.0	63.0	− 3.0	− 0.3
	Basal + Ry + Bi	10	2.0	60.0	− 2.5	0.3
62	Basal + Ry + Bi + Fo	16	2.1	57.5	0.5	0.0
	Basal + Ry + Bi + Fo + LEL¶	24	3.8	58.0	30.0	1.3
	Basal + Ry + Bi + Fo	8	4.0	88.0	1.0	0.1
	(Without Sulfasuxidine)					
88–91 Avg (4)	Basal + Bi + Fo	26	5.4	100.6	37.9	1.5

* The basal diet consisted of a 17% amino acid mixture (*5*) and 0.83% homocystine. When Sulfasuxidine was fed it was added to the basal diet, which was given *ad libitum*. Rats 88–91 were restricted to 6 g of the diet for the first 16 days and ate *ad libitum* for the next 10 days. The standard dose of B vitamins was 500 γ each of nicotinic acid, *p*-aminobenzoic acid, and inositol, 200 γ of calcium pantothenate, 40 γ each of thiamin hydrochloride, riboflavin, and pyridoxine hydrochloride, and 0.25 γ biotin (*5*). The ryzamin-B, extra biotin, folic acid, and LEL were added to the standard vitamin mixture and fed daily. DL-Homocystine (100 ± 0.5% by disulfide determination) was prepared in this laboratory by du Vigneaud's method modified by Brand (*6, 7*).

† Rats 34–37 were put back on the folic acid supplement in approximately 30 days and grew at practically the same rate for nearly 30 additional days, when the growth curves leveled off. When killed after 220 days on the synthetic diet, they weighed 181, 168, 166, and 153 g, respectively. On autopsy their livers did not appear fatty and weighed 7, 6, 8, and 6 g. Microscopic examination showed moderate fatty infiltration of the liver and some tubular degeneration of the kidneys.

‡ Ry signifies 62.5 mg of ryzamin-B unfortified (Wellcome Research Laboratories).

§ Bi signifies 2 γ of biotin. Rats 88–91 received 1 γ of biotin.

‖ Fo signifies 20 γ of folic acid (Folvite Lederle).

¶ LEL signifies 60.0 mg of Liver Extract Lilly.

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[1] Aided by a fund in memory of Ruth C. Joyce.

Under these conditions the rate of growth is quite consistent; the presence of folic acid seems to prevent the acute reversible drops in weight observed in previous experiments (*4*). Of 12 rats studied on this diet, only one rat, number 90, showed a slight drop in weight with food consumption dropping to zero for one day. This rat also showed an early leveling-off of her growth curve on the 15th day of the reported period; the growth of the other rats did not level off until after the 26-day period.

The above experiments indicate that rats do not always lose their ability to utilize homocystine, under the conditions prevailing in these experiments, even though their intestinal folic acid synthesis has been checked by the sulfa drug, since addition of large doses of crystalline folic acid enables some rats to continue growth. The fact that only some rats respond to folic acid indicates that it is not the only factor involved. These animals retain a latent capacity for the utilization of homocystine, which seems to depend for its manifestation on a fairly high level of folic acid and is not destroyed by the sulfa drug. The nature of the variability of the growth response becomes apparent when we realize that other vitamin B factors are probably involved, the most conspicuous one being B_{12}. These factors may be stored in the animals in varying amounts from preexperimental diets and may therefore be depleted in single animals at different periods of the experiment. Work is now under way to elucidate these problems.

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Separation of the Ionic Species of Lysine by Means of Partition Chromatography[1]

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It is a cardinal principle in chromatography that for each compound there is only one position on the chromatogram; this locus is unique in the sense that all of the substance is contained within that position, but not in the sense that entirely different substances may not also occupy that position. As a corollary, it is believed that the appearance of two or more loci of substance indicate the presence of two or more different compounds. It is the purpose here to cite exceptions to this corollary, viz., that the presence of more than one locus of concentration may still be identified with a single substance.

We have found that paper partition chromatography of lysine[3] in a saturated phenol > water system may result in a plurality of spots. If from a relatively large volume of aqueous solution of lysine, small aliquots are taken for partition chromatographs, the number and position of these spots will depend upon the pH of the aqueous solution of the lysine (see Fig. 1). The relative intensities will be in rough accord with the distribution of ionic species for the different pH's as calculated from ioniza-

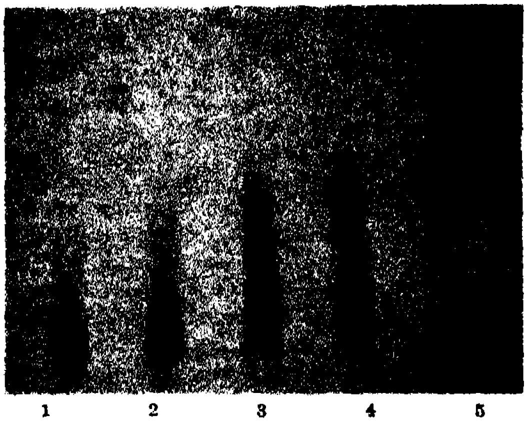

FIG. 1. Ninhydrin-developed spots of lysine aliquoted at various pH's: 1 at 2.20, 2 at 8.45, 3 at 9.50, 4 at 10.62, and 5 at 12.15.

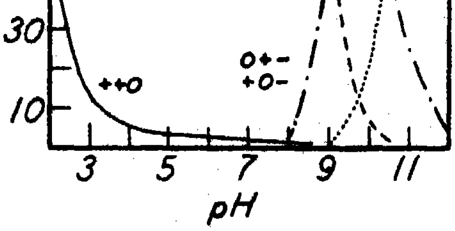

FIG. 2. The distribution of ionic species of lysine at various pH's.

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[1] Work supported in part by the Ames Laboratory of the Atomic Energy Commission under Contract W-7405-eng-82.

[2] The author desires to acknowledge the assistance of Mr. Leo Vernon in a portion of this work.

[3] The lysine was purified by two recrystallizations, once as the picrate and again as the dihydrochloride. This procedure was followed for three different sources of material, all of which gave the same results: synthetic DL-lysine (monohydrochloride), naturally-occurring L-lysine (monohydrochloride), and lysine regenerated from the hydrolysis of aminohomopiperidone, and precipitated as the dihydrochloride. Melting points were in agreement with values in the literature (*1*).

tion constants (see Fig. 2). An unequivocal assignment of the spots to corresponding species is not necessarily possible, e.g., as in the two acid lysinates. The R's subject to temperature fluctuations, appear to correspond, respectively, to the free acid (++o) as 0.30, lysinate (++−) as 0.35, acid lysinates (o+− and +o) as 0.48 and 0.65, and free base (oo−) as 0.74.

The effect is absent in a basic solution, as collidine-water, or in a more economical medium which we have found equally effective for amino acid chromatography, butanol-water-pyridine (1: 1: 0.6). In either solvent the phenomenon does not appear with a polybasic amino acid, such as aspartic acid. It is possible that the use of stronger bases, such as the aliphatic amines, would be more effective with the weakly acidic groups. In phenol-water, arginine also yields long streaks rather than discrete spots, indicating a situation akin to that of lysine. The absence of the effect with histidine may perhaps be correlated with the relative weakness of its basicity.

An explanation of the phenomenon can probably be given along lines similar to those advanced by Westall (*2*) for the separation of inorganic ions in partition chromatography, i.e., basic lysine ions are capable of association with phenol. These associations are essentially new compounds, possessing their own partition coefficients and moving independently without charging the phases. The explanation assumes that in the phenol system the dissociation of phenol is so small that it does not cause drastic acidification of basic ions of lysine. Rough calculation of the volume of water in the phenol > water system bathing the spots shows that it probably does not exceed that used in the original aliquot; there is therefore no appreciable change of the intrinsic pH by dilution.

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Demonstration of a Fatty Acid Oxidase in Frozen Poultry Fat[1]

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Lipoxidases have been shown to exist in plant material (*6*) and in animal tissues (*1, 2*). The Warburg technique has been used to demonstrate the ability of microorganisms to oxidize fats (*2*). The adipose tissue of rats has been shown to be enzymatically active (*3, 5*).

In the course of a study on the causes of rancidity of frozen chicken fat, an enzyme was prepared which oxidizes fatty acids. All birds[2] were killed by sticking, then were drawn, and frozen at 0° F. The adipose tissue was removed by permitting the carcass to thaw enough for skinning. Fat deposits from around the neck, the visceral cavity, and on the body were removed and pooled. Care was taken to include no muscle, skin, or connective tissue. This collected material was kept frozen until used—a period varying from 1 week to 3 months.

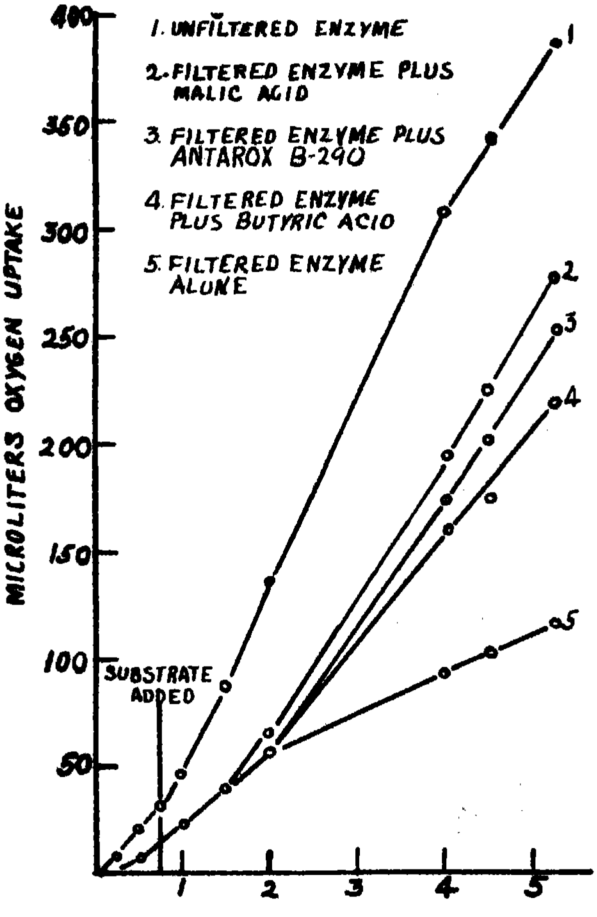

Fig. 1. Effect of different substrates on the oxygen uptake of the fatty acid oxidase.

The enzyme was prepared by expressing the fat away from the tissue portion of the adipose material. The separated tissue was blotted on absorbent paper to remove excess fat, weighed, and homogenized with distilled water in a Potter homogenizer (*4*), 1 g of tissue in 30 ml of water. This mixture was centrifuged, the supernatant collected, and the residue washed twice by centrifuging with distilled water (10 ml of water for 1 g of tissue). Washings were combined with the previously prepared supernatant. Microscopically, the homogenate showed that some cell debris and fat globules were retained.

Using a Warburg Respirometer and an atmosphere of air at 37° C, the homogenate had an induction period of 4–6 hr (average of eleven trials was 5 hr). After the induction period in the presence of phosphate, Mg ion, and adenosine-5-phosphoric acid, there was a steady oxygen uptake, varying from 30 to 100 µl/hr (average of nine trials was 65 µl). Respiration continued for approximately 24 hr. Attempts to demonstrate the substrate for this respiration were unsuccessful.

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[2] We wish to thank Dr. W. J. Stadelman, of the Washington State College Poultry Department, for supplying the birds used in this work.

The homogenate was combined with 1.2 volumes of 0.01 M phosphate buffer (pH 7.5) and 0.2 volumes of 0.04 M $MgSO_4$, filtered to remove fat globules, and aged at 37° C for 24–29 hr. Very little respiration was shown by 2.4 ml of this preparation with the addition of 0.2 ml of 0.0028 M adenosine-5-phosphoric acid. The addition of glucose as a substrate did not change the respiration. The addition to this mixture of 0.2 mM of oleic acid, linoleic acid, palmitic acid, stearic acid, tripalmitin, tristearin, butyric acid, acetic acid, or 3.3 mg Antarox B-290[8] (a water-soluble castor oil polyethylene glycol ester) approximately doubled the oxygen uptake. Malic and fumaric acids, members of the tricarboxylic acid cycle, also doubled the oxygen uptake. Acids were neutralized with NaOH before using. A portion of the enzyme-phosphate-magnesium ion mixture which had been aged, but not filtered, showed a higher respiration than any of the substrates added to the filtered preparation.

Boiling the aged and filtered homogenate for 30 sec destroyed enzymatic activity. Dialysis of the unfiltered mixture against phosphate buffer and Mg ion during the aging period also decreased activity markedly.

Adipose tissue from five birds was used in this work and it was observed that there were large variations in the activities of preparations from different birds, and fat deposits from different parts of the same bird.

Further work is being carried out on substrates for this preparation and on the path of the oxidation.

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A Simple Jet Type Air Stirrer[1]

G. C. Potter and **F. A. Kummerow**

Kansas Agricultural Experiment Station, Manhattan

The paddle wheel type of air stirrer has been used in organic laboratories in order to reduce fire hazards. However, this type of air stirrer is noisy, clumsy, and lacks power. The jet type stirrer described in this article is almost noiseless in operation, compact, and has more speed and almost as much power as a variable speed stirrer.[2]

The jet type stirrer can be made most conveniently from a 1-in. steel ball and brass or steel jets[3] (Fig. 1). A hole ¼ in. in diam and ¼ in. deep must first be drilled into one side of the steel ball, and a piece of steel ¼ in. in diam and 1¾ in. in length (A) inserted into the hole and brazed to the steel ball. The upper part of this 1¾-in. steel rod serves as a means of holding a ball-bearing race[4] and cone (B) and the lower part serves as a shank to which a stirring rod can be attached with either a piece of heavy rubber tubing or an ordinary steel chuck. A hole ¼ in. in diam and ⅛ in. deep (C) must then be drilled directly opposite the steel rod, and three holes 3/32 in. in diam (D) at a 120° angle to each other drilled so as to contact the lower half of the hole which had been drilled at (C). The three holes at (D) are then threaded, and threaded brass or steel jets screwed into them. These jets are bent slightly at point (E). The hole at point (C) is also threaded and a ¼-in. threaded steel tube screwed into it. The upper end of the steel tube holds another ball-bearing race and cone and a babbit bearing at (F). Another piece of steel tubing 1¼ in. in length is threaded at one end and screwed into the bicycle cone. A piece of heavy rubber tubing is connected to the upper end of this steel tube and serves as an air inlet (G). The apparatus is held rigid by the steel bracket (H) clamped to a ring stand at (J). The speed of the stirrer can be adjusted by regulating the flow of compressed air.

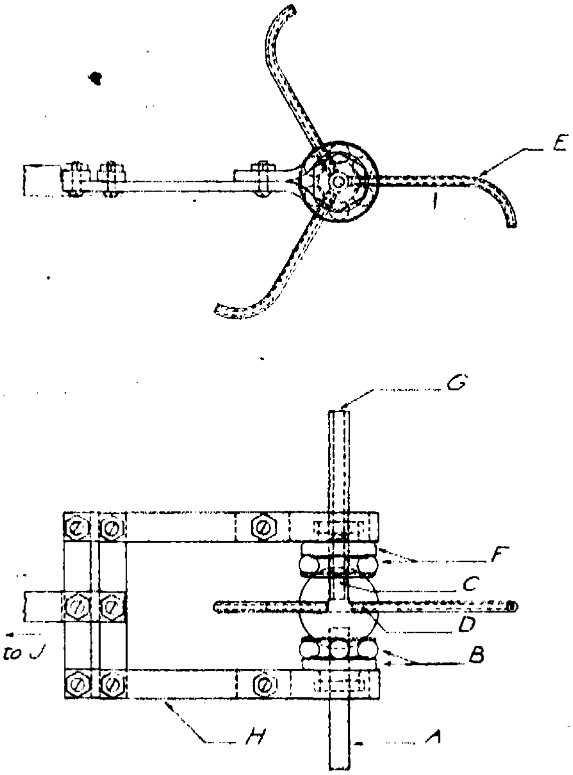

FIG. 1. Diagram showing construction of stirrer (guard around jets of hardware cloth 2 in. in width is not shown).

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[1] Contribution No. 384, Department of Chemistry. Funds supplied by Office of Naval Research and Bureau of Animal Husbandry under Research and Marketing Act.

[2] Cenco, Central Scientific Apparatus Company, Chicago.

[8] Sample of Antarox B-290 from Antara Products, New York.

[3] Ford V-8 carburetor jets or ¼-in. steel capillary tubing.

[4] Front wheel bicycle race and cone.

Comments and Communication

Do Amino Acids Fluoresce on Papergrams?

Before amino acid papergrams are treated with ninhydrin, it is customary to drive off the residual solvents by heating. It has been observed that the amino acid spots fluoresce under ultraviolet light at this stage, and fluorescence is frequently used when it is desired to locate the amino acids without reacting them with ninhydrin. This has led to an assumption which appears unwarranted, that it is the dry amino acids themselves that fluoresce.

In experiments with glycine and Whatman No. 1 filter paper, we have found that after heating, unchanged glycine can be extracted by washing with water, but the fluorescence remains behind on the paper. This, incidentally, leads to errors if an area located by fluorescence is water-extracted for subsequent evaluation by ultraviolet absorption. It is easy to demonstrate that the paper is essential for the development of fluorescence. We have air-dried spots from solutions of 21 common amino acids on filter paper (Whatman Nos. 1 and 50), and on glass plates. None of the dry spots fluoresced under ultraviolet light in the 3650-A region. After a few minutes' heating at 105° C, all the paper spots fluoresced. The spots on hardened paper fluoresced more brilliantly at first, but 3 hr of additional heating obliterated this difference.

None of the amino acid spots on glass fluoresced, even after 24 hr of continuous heating. A typical example may be seen in the figures. They show spots of the same amino acid (cystine), heated under identical conditions, on Whatman No. 50 paper and on glass. Photographed under tungsten light (Fig. 1), the paper spot is invisible and the glass spot is faintly outlined by a border of dried crystals. Photographed in the dark under ultraviolet light with process pan film and a Wratten A red filter (Fig. 2), the paper spot glows with fluorescence and the corresponding spot on glass is invisible because it does not fluoresce.

The production of fluorescence may be due to a reaction between the amino acid and the cellulose, similar to the nonenzymatic browning reaction. Most amino acid spots become visibly brown after prolonged heating. For example, 3 g glycine in solution, pulped with 60 sq in. Whatman No. 1 paper in a Waring Blendor and evaporated to dryness, showed brown discoloration and intense fluorescence after 6-hr heating. Neither browning nor fluorescence occurred under identical conditions with glycine or filter paper alone. It seems obvious that the molecular structure of the amino acid is not a prime factor in producing such fluorescence. All the amino acids produce similar results, the *sine qua non* being the filter paper. Heating speeds up the reaction but is not

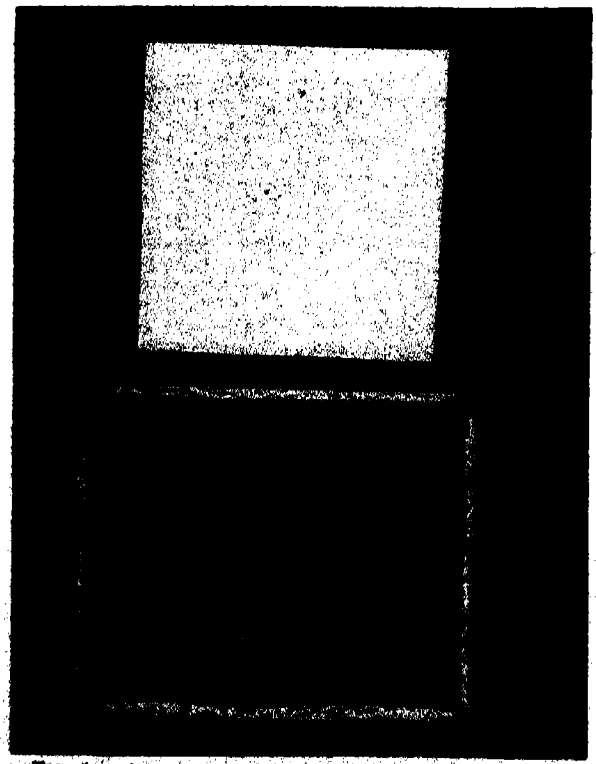

FIG. 1. Appearance of heated amino acid spot on filter paper and glass plate under tungsten light.

FIG. 2. Heated amino acid spot on filter paper and glass plate under ultraviolet light in the 3650-A region.

necessary; fluorescence develops slowly at room temperature. Drying from solution does seem to be necessary for the close contact required.

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The Coxsackie Group of Viruses

It has become desirable to name those viruses that are pathogenic for suckling mice and hamsters, and that have recently been associated with "poliomyelitis" (Dalldorf, G. and Sickles, G. M. *Science*, 1948, 108, 61; Dalldorf, G. *et al. J. exp. Med.*, 1949, 89, 567; Melnick, J. L., Shaw, E. W., and Curnen, E. C. *Proc. Soc. exp. Biol. Med.*, 1949, 71, 344). I have felt that the disease should not be named until something is known of the anatomic lesions in man and a good deal more is learned of the range of symptoms and the relationship, if any, to classical poliomyelitis. On the other hand, a provisional designation is needed and it is suggested that the agent be called "Coxsackie virus," since the first recognized human cases were residents of that New York village. Since a number of viruses may be involved, the term "Coxsackie group of viruses" seems especially suitable. This provisional nomenclature has the support of those workers known to us to have experience with these agents, namely, J. L. Melnick and E. C. Curnen, of the Yale School of Medicine, and G. E. Quinby, R. S. Paffenbarger, and Beatrice Howitt, of the Communicable Disease Center, U. S. Public Health Service.

The term may properly be applied to viruses having the unusual host range described in published studies and the faculty of inducing severe, destructive lesions of the striated muscles, with or without encephalomalacia in immature mice and hamsters.

It is hoped that strain identification will be made only after reference to those strains that have now been studied.

Gilbert Dalldorf

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New York State Department of Health,
Albany

Basic Issues in the Controversy on Zoological Nomenclature

A very important and basic controversy is now going on in zoological nomenclature. So far only scattered comments have appeared in public and these few statements present conflicting views. It is apparent to the members of this discussion group[1] that the basic issues have not been sufficiently emphasized.

At Paris in July 1948, the International Commission on Zoological Nomenclature, which there consisted of four regular commissioners and eight or nine alternates appointed for the occasion, adopted a far-reaching program of reform, a program prepared at great length by the secretary. This program included (1) authorization for a rewriting of the code around a set of stated principles; (2) action on a large number of individual amendments, none of which had previously been voted on by the commission; (3) entrusting to "jurists" the preparation of the text of the new code in "watertight legal language"; and (4) a complete reorganization of the commission, its size, its method of selecting members, and its bylaws. Most of this was without advance notice to zoologists or to the commission, and neither the commissioners nor the alternates at Paris had opportunity to study the voluminous agenda in advance of the meeting.

The following facts stand out as the basic issues: (1) the most momentous actions of a half-century in zoological nomenclature were taken at Paris without preliminary announcement, without the usual opportunities for consideration by zoologists in general, and without prior study and approval by the regular commissioners; (2) in many cases approval was given only "in principle," with no provision for review of the principles and with the actual wording left to a committee of jurists; (3) not only was no provision made for review of these principles, but no right was reserved for the regular commission, the international congress, or zoologists to accept or reject the final wording of the proposed revision or any of its parts before promulgation.

It is clear that the program which produced these issues was created and fostered by the secretary of the commission, who no doubt believed that his actions were desirable and necessary to improve the nomenclatural situation. Nevertheless, shorn of all obfuscations regarding "mandates from the congress," dangers of delay, and similar assertions, the means taken to effect the ends are contrary to the principles and practices on which international cooperation in nomenclature was established and by which it has functioned for nearly half a century.

Such actions strike at fundamentals. If they are allowed to stand, international cooperation in nomenclature will be a farce, the confidence upon which support of the commission has been based will be lost, and the accomplishments of years in the field of zoological nomenclature will be jeopardized.

If confidence is to be maintained and international cooperation made secure, any plan for revision of the code must have widespread approval. Zoologists must be permitted to see any such proposals and express their reactions, the full commission must study all proposals, as well as the comments of zoologists, and pass judgment on them, and, if it still seems desirable to maintain the formality, the following International Congress of Zoology must formally approve the final draft.

Steering Committee,
Nomenclature Discussion Group

Washington, D. C.

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[1] The Nomenclature Discussion Group consists of 71 taxonomists of the Smithsonian Institution, the U. S. National Museum, the Bureau of Entomology of the U. S. Department of Agriculture, the Paleontology Branch of the U. S. Geological Survey, the Fish and Wildlife Service of the U. S. Department of the Interior, and the U. S. Public Health Service. This statement is signed by the members of the Steering Committee, as follows: R. E. Blackwelder, F. A. Chace, E. A. Chapin, D. H. Dunkle, R. Kellogg, J. B. Knight, C. F. W. Muesebeck, P. W. Oman, H. A. Rehder, C. W. Sabrosky, A. Stone, and A. Wetmore.

NEWS and Notes

The Royal Swedish Academy of Engineering Sciences has elected to membership **Glenn T. Seaborg,** Swedish-born chemist at the University of California in Berkeley.

Herman Mark, director of the Polymer Research Institute at the Polytechnic Institute of Brooklyn, has been invited by the Indian National Research Council to visit India in January and February and to deliver lectures on the scientific and practical aspects of the physics and chemistry of high polymers in universities and research institutions in Bombay, Delhi, Calcutta, Bangalore, and Madras. He will address the meeting of the Indian Academy of Sciences, December 29–31, in Bombay, and that of the Indian Association of Science in Poona, January 2–8. Dr. Mark is a member of the Indian Academy of Sciences.

Holbrook Mann MacNeille, chief of the Fundamental Research Branch of the U. S. Atomic Energy Commission, assumed executive directorship of the American Mathematical Society on November 14.

Lyman C. Craig, of the Rockefeller Institute for Medical Research, will deliver the third Harvey Lecture of the current series at the New York Academy of Medicine on December 15. Dr. Craig will speak on "Isolation and Characterization of Biologically Important Substances."

Perry W. Gilbert, associate professor of zoology at Cornell University and currently on sabbatic leave, is studying the origin and development of the human extrinsic ocular muscles as a guest investigator at the Carnegie Laboratory of Embryology, Baltimore. Dr. Gilbert will resume his teaching duties at Cornell on February 1.

George G. Gallagher was recently appointed assistant manager of the Raw Materials Operations Office of the U. S. Atomic Energy Commission, where he will have direct supervision of the domestic uranium program of the AEC. He replaces **Jesse C. Johnson,** who recently became deputy manager. Before joining the AEC staff, Mr. Gallagher was general superintendent of the Compania Minera Venturosa in Mexico. During the war and until 1947 he was an engineer examiner in the mining section of the Reconstruction Finance Corporation.

William Vogt has resigned as chief of the Conservation Section of the Pan American Union, effective November 15.

John B. Youmans, dean of the University of Illinois College of Medicine, has resigned to take a similar post at Vanderbilt University, effective March 1, 1950. Dr. Youmans will succeed **Ernest Goodpasture.**

Guenter Schwarz and **George L. Rogosa** joined the staff of the Florida State University Physics Department this fall. Both men were formerly at the Institute of Cooperative Research, Johns Hopkins University.

Walter G. Schindler, Rear Admiral, USN, has been made deputy chief of research at the Navy's Bureau of Ordnance. He succeeds **Frederick I. Entwhistle,** Rear Admiral, USN.

Visitors to U. S.

George Vaux, French archaeologist and professor at the Sorbonne is a visiting member of the Harvard University Classics Department, where he will lecture on Delphi.

Yoshio Kusama, chairman of the Japanese Council on Medical Education, and professor of preventive medicine at Keio University Medical School, Tokyo, is making a tour of leading American medical centers. He will return to Japan about the middle of February.

Sunder Lal Hora, director of the Zoological Survey of India, Indian Museum, Calcutta, visited centers of zoological, fisheries, and oceanographic research in this country last month. During his stay he lectured at Yale, Berkeley, Washington University, and the University of Michigan, and at the National Museum and the Fish and Wildlife Service at Washington, D. C. His subjects were fish farming, with special reference to Indian and Chinese practices; study of adaptations among torrential fishes of India; and the zoogeography of India.

Visitors at the National Bureau of Standards last month included **N. D. Hill,** engineer, Research Laboratories of Elliot Brothers, London; **R. M. LeLacheur,** research physicist, National Research Council of Canada, Ottawa, who will be here for several weeks; **Torvald Malmstrom,** assistant director, Swedish Royal Academy of Engineering Sciences, Stockholm; **D. H. Sadler,** superintendent of H. M. Nautical Almanac Office, Royal Greenwich Observatory, Hailsham, Sussex; **F. Svensson,** of the Aeronautical Research Institute of Sweden; **Manuel S. Vallarta,** professor at the University of Mexico, temporarily wth the Institute for Advanced Studies, Princeton; **Max Freson,** secretary, National Research Council, Brussels; **A. C. Menzies,** physicist, and controller of Research and Development, Hilger and Watts, Ltd., London; **S. A. Shareef,** director of engineering development, Government of Pakistan; and **A. C. S. van Heel,** professor, Technical University of Delft, Netherlands.

E. E. Evans-Pritchard, professor of anthropology at All Souls College, England, will be a visiting professor in the University of Chicago's Department of Anthropology during the winter quarter.

Abelardo Moreno, of the University of Havana, is in Washington, D. C. on a Guggenheim fellowship for one year's study. Dr. Moreno may be reached at the National Museum, Division of Birds.

Simón Markovich, head of the Department of Neurophysiology at the Central Institute of Neurosurgery and Neuropathology, Santiago, is at Columbia University for a year's postgraduate work. Dr. Markovich has a U. S. Public Health Fellowship.

Grants and Awards

The American Institute of Chemists will award its 1950 gold medal to Walter J. Murphy, editor of the American Chemical Society's *Chemical and Engineering News*, *Industrial and Engineering Chemistry*, and *Analytical Chemistry*. The medal is awarded annually for noteworthy service "to the science of chemistry or the profession of chemist in America." Dr. Murphy was cited as "a great editor, who has focused the world's attention on chemists and their contributions as professional men." He will receive the award at the institute's annual meeting in New York in May.

The Harvard Foundation for Advanced Study and Research announced last week that the university had received an unrestricted gift of $50,000 from the Mallinckrodt Chemical Works of St. Louis.

The Albert and Mary Lasker Foundation awards for 1949 of the Planned Parenthood Federation went to Carl G. Hartman for his researches in embryology and reproduction, particularly in regard to ovulation, and to George M. Cooper for his outstanding services to maternal and child health in North Carolina.

The Nutrition Foundation, Inc. has approved grants-in-aid to the following institutions: University of California—$3,000 annually for two years to *M. S. Dunn* for the study of the functions and microbiological analysis of amino acids; University of Cincinnati—$2,500 annually for two years to *Joseph Warkany* for the study of diet and congenital malformations, and $5,000 to *G. M. Guest* for clinical and experimental research on diabetes, especially in the young; University of Rochester—$2,000 to *K. E. Mason* for the study of the nature and significance of a pigment associated with vitamin E deficiency; University of Minnesota—$4,600 for two years to *P. D. Boyer* for studies on the metabolic function of vitamin E; A. & M. College of Texas—$2,000 annually for two years to *C. M. Lyman* to study the biochemical reactions leading to the synthesis of amino acids; Syracuse University—$3,000 to *W. W. Westerfeld* to study carbohydrate and purine metabolism; University of Iowa—$1,800 annually for two years to *C. P. Berg* to study the metabolism of amino acids; University of Florida—$2,500 annually for two years to *G. K. Davis* to study the interrelationships of molybdenum, copper, and phosphorus in animal metabolism; Western Reserve University—$1,500 to *I. Pyle* and *N. L. Hoerr* for charts on the bone development in children and reference standards based on x-ray records; Children's Hospital, Boston—$5,000 to *S. B. Wolbach* to study vitamin and mineral deficiencies and excesses; University of Pittsburgh School of Dentistry—$3,000 to *Gerald J. Cox* to study factors in the diet that control tooth development, and $3,000 annually for two years to *B. F. Daubert* to study the development of methods for the micro-estimation of unsaturated fatty acids; Cornell University Medical College—$3,000 annually for two years to *Donald B. Melville* to study the biochemical significance of compounds related to histidine, and $3,600 annually for three years to *Richard E. Lee* to study the dietary factors involved in maintaining the integrity of the peripheral vascular system; and Columbia University—$4,000 annually for two years to *D. Rittenberg* to study precursors of cholesterol.

Colleges and Universities

The University of Chattanooga formally dedicated its new $500,000 science building on November 19. The building is named Brock Hall in honor of William E. Brock, former U. S. Senator, who has served for 30 years on the university's board of trustees. The building's medical research laboratory, established by John B. Haskins, Chattanooga physician, was also dedicated and is to be known as the John B. Haskins, Jr. Memorial Laboratory.

Stevens Institute of Technology's Graduate School has opened a laboratory for its recently established Department of Fluid Dynamics. The laboratory is equipped for research in the mechanics of fluid flow by visualization processes such as shadowgraphy, striation photography, and interferometry. A two-dimensional wind tunnel, designed by Bela K. Erdoss, chairman of the new department, is being built in the laboratory.

Meetings and Elections

The American Geological Institute held its second annual meeting November 13 in El Paso, Texas. The meeting was devoted primarily to a consideration of the long range program of the institute, the election of officers for 1950, and discussion of several projects which should be completed within the next few months.

Officers elected by the board of directors for the coming year are: president, William B. Heroy, Beers and Heroy, Dallas; vice president, Earl Ingerson, U. S. Geological Survey, Washington, D. C.; secretary-treasurer, Ernest Cloos, The Johns Hopkins University, Baltimore.

The institute is composed of 11 national scientific and professional societies. The constitution provides, however, that nonprofessional organizations interested in the geological sciences may be admitted as nonvoting affiliates, and the board voted to encourage the affiliation of such organizations whose programs are consistent with the objectives of the institute.

The board also adopted a program to assist the progress of geological work and research. The program will include specific activities concerned with the training of professional geologists, the role of geological material in general education at the college level, the integration of geological material in school curricula and in adult education, and an investigation of the entire method of teaching geological science. Specific plans for cooperation with state education commissions, state geological surveys, and local educational institutions are being studied.

The scope and nature of the present program of geological field education offered during the summer months are also under study. A report describing all summer geology field courses to be offered in 1950 and summarizing the 1949 program will be issued soon. The institute also plans to compile specific information concerning the utilization of earth science in the high school curricula throughout the U. S.

The report of the Committee on Geological Personnel showed that the wartime deficit of geologists trained to the bachelor level has been overcome. As a result, the institute will initiate early next year an annual supply and demand study of geological personnel, combined with a study of both the training and the personal qualities which have led to success in various types of geological endeavor, and an investigation of present functional distribution of geologists in the U. S.

The compilation of a catalogue of geological field trip guidebooks, with index maps showing areas covered by each, is also planned. A number have been prepared by agencies including the U. S. Geological Survey, the International Geological Congresses, and local societies. Many state geological societies have issued valuable guidebooks in connection with their annual field tours. For example, the field trips sponsored by the El Paso meeting of the Geological Society of America were covered by a series of excellent guidebooks prepared by the West Texas Geological Society, but much of the original information, which is highly scientific, has never been published. The proposed compilation should be of use to professional geologists, students, and amateurs studying these regions.

Another study will deal with the exchange availability of geological material useful in teaching or for display. In the past, exchanges have largely been arranged by individual geologists. The proposed catalogue will make this information available to geology departments and others who wish to build up their teaching and display materials.

An analysis of unpublished research in geological science will also be undertaken, primarily in the North American continent. It is planned to compile this information annually or biannually for the assistance of research workers in the geological sciences. An investigation of the current status of geological mapping in the U. S. will also be made as a basis for recommendations for future action in this area of geological work.

The board of directors also approved a public information program through the use of local speakers and nontechnical pamphlets and guides to inform the public about geological features of state and national parks and areas of scenic interest. This would include a speakers' bureau to supply speakers on nontechnical geological subjects to interested organizations. The program will be integrated at the state and local level.

The board endorsed a program of specific cooperation with the National Defense Establishment concerning the use of geological techniques and geologists in national defense, and proposed a careful analysis of the means whereby the institute may be of service to federal and state agencies participating in or sponsoring geological programs. Recommendations of the Committee on Publications to study the possibility of publishing a monthly journal of geological abstracts were also approved.

The board emphasized that the function of the institute is to serve the geological profession, and thereby the individual geologist. The success of the program will depend on the participation of individuals and those interested in any phase of the program are urged to write to institute headquarters.

DAVID DELO, *Secretary*

Two state academies of science will hold meetings this week: The **Tennessee Academy of Science** at Southwestern University, Memphis, Tennessee, December 2–3, and the **Oklahoma Academy of Science,** at Phillips University, Enid, Oklahoma on December 2.

The American Institute of Mining and Metallurgical Engineers elected the following officers at the meeting of the board of directors, November 16: president, Donald H. McLaughlin, head of the Homestake Mining Company, San Francisco; vice presidents, Andrew Fletcher, president of the St. Joseph Lead Company, and Robert W. Thomas, general manager of the Nevada Consolidated Copper Corporation.

Deaths

Clarence Olds Sappington, 60, authority on industrial medicine and hygiene, died of a heart ailment November 6 at his home in Chicago. Dr. Sappington was editor of *Industrial Medicine and Surgery,* and director of the Division of Industrial Health of the National Safety Council from 1928 to 1932.

Harry T. Gisborne, 56, chief of the Division of Forest Fire Research at the Northern Rocky Mountain Forest and Range Experiment Station, died of a heart attack November 9. Mr. Gisborne was internationally known for his method of calculating fire hazards in forests through measurement of humidity, fuel moisture, precipitation, and wind velocity. Shortly before his death he worked with General Electric engineers on experiments to control lighting.

George B. Sartoris, 53, principal agronomist, Division of Sugar Plant Investigations of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, died of a heart attack at his home in University Park, Maryland, November 19. Dr. Sartoris had been a member of the department since 1923; he had been engaged in breeding research on sugar cane since 1934. At the time of his death he was in charge of the sugar cane and sugar sorghum projects of the bureau.

Daniel B. Feer, 25, assistant professor of physics in the College of Engineering, New York University, died of a heart attack on November 8. Dr. Feer specialized in the quantum theory of fields and in elementary particle physics. During the war he was a special research associate in the Electroacoustic and Systems Research Laboratories of Harvard University. He spent the year 1948–49 in the School of Mathematics of the

Institute for Advanced Study at Princeton.

Representatives of the U. S. Atomic Energy Commission and the Government of the United Kingdom recently conferred with the South African Atomic Energy Board on problems relating to the production of uranium in the Union of South Africa. The discussions, held in Johannesburg, were a continuation of previous conferences of the three governments. Representatives of the U. S. were J. K. Gustafson, manager of the AEC Raw Materials Operations Office; Thorold Field and Robert Macdonald, technical advisers to Dr. Gustafson; and A. A. Wells, special assistant to the AEC General Counsel.

The Council of the Organization for European Economic Cooperation, composed of representatives of all countries receiving Marshall Plan aid, has agreed that each of the 18 governments will make available to all the others documents dealing with scientific, technological, and economic matters of importance to industrial production. The exchange is expected to begin early next year and will provide for translation and reproduction of documents, subject to agreement of the country supplying them. The council also urgently recommended compilation of national surveys of documentary sources and technical information services, as well as listings of leading experts and research units in various technical fields.

Laboratory training courses in communicable diseases will begin January 1 at the Communicable Disease Center, Atlanta, Georgia. Twenty-five courses of one to four weeks' duration will be offered during the year. Information and applications should be requested from the Chief, Laboratory Division, Communicable Disease Center, 291 Peachtree Street, N.E., Atlanta, Georgia.

The Oak Ridge Institute of Nuclear Studies announces that some vacancies still remain for the winter series of three radioisotope techniques courses offered by its Special Training Division (see *Science*, October 7, p. 386). Interested persons are urged to apply for one of the winter courses, in view of the heavy load of applications for participation in the summer courses. Starting dates are January 2, January 30, and March 6. Requests for application and information should be addressed to Dr. Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

The Kresge-Hooker Scientific Library is seeking to fill the vacancy created by the death of Neil E. Gordon, Wayne University chemistry professor. Qualifications include ability to edit the *Record of Chemical Progress*, direct off-campus translational services of the library, direct other library activities among chemists in industrial and academic fields, and do part-time teaching in the chemistry department. The rank of professor is available for the position. Applications should be addressed to The Friends of the Kresge-Hooker Scientific Library, Wayne University, Detroit 1, Michigan.

Recently Received—

Agricultural Climatology of Japan and Its Agro-Climatic Analogyes in North America. M. Y. Nuttonson. International Agro-Climatological Series, Study No. 8, 1949. On request from American Institute of Crop Ecology, P. O. Box 1022, Washington, D. C.

Life at Letchworth Village. 40th annual report, Board of Visitors, March 31, 1948. Department of Mental Hygiene, Albany, New York.

Proceedings of the Hawaiian Academy of Science. 24th annual meeting, 1948–49. University of Hawaii, Honolulu, T. H.

Department of Scientific and Industrial Research Report, 1947–48, with review of 1938–48. His Majesty's Stationery Office, London, 2 S.

Bausch & Lomb Optical Glass. Catalog E-30. Bausch & Lomb Optical Company, Rochester 2, New York.

The Electron Microscope and Its Application to Materials Problems, PB 97957. Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. $1.25.

Stress Analysis. Armour Research Foundation, Illinois Institute of Technology, Technology Center, Chicago 16.

Report on the Principles of Rheological Nomenclature. H. M. Burghers and G. W. Scott Blair. Joint Committee on Rheology of the International Council of Scientific Unions. North-Holland Publishing Company, Amsterdam.

Guide for the Identification and Reporting of Stranded Whales, Dolphins, Porpoises, and Turtles on the British Coasts. F. C. Fraser and H. W. Parker. British Museum, London. 2 S.

Exploradores Famosos de la Naturaleza Venezolana. Eduardo Röhl. Third Inter-American Agricultural Conference. El Compás, Caracas, Venezuela.

Catalog of Periodical Publications in the Libraries of Mexico City. Section of Medicine and Biological Sciences. Benjamin Franklin Library, Mexico, D. F.

Guide to the Medicinal and Poisonous Plants of Queensland. L. J. Webb. Council for Scientific and Industrial Research, Bull. 232, Melbourne, Australia.

Make Plans for—

American Academy of Optometry, annual meeting, December 10–13, Cleveland, Ohio.

Entomological Society of America, 44th annual meeting, Tampa, Florida.

American Psychoanalytic Association midwinter scientific meeting, December 17–18, Hotel Statler, New York City.

American Chemical Society, 16th annual chemical engineering symposium, December 29–30, Ohio State University, Columbus.

American Meteorological Society, 104th national meeting, January 4–6, Hotel Jefferson, St. Louis, Missouri.

The Good Name of Science: A Discussion of Science Courses for General Education in College

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HOW CAN WE SAFEGUARD the good name of science among educated people? How can science courses in college and school give the general public a real understanding of science? The need is serious. This is a scientific age, in which the results of science affect everyday living, the thinking of scientists affects intellectual patterns, and scientists hold controlling knowledge and skill in industry, in warfare, and in matters that affect the whole policy of commerce and government. Lack of understanding between scientists and administrators brings difficulties and dangers. Administrators in businesses and in governments, even heads of governments themselves, all have to meet with scientists and formulate policies and make decisions which depend on scientific judgments; yet they find themselves ill prepared to understand the scientists' point of view or to assess their statements.

Just as serious is the problem of the general public, of the thinking man who wants to understand science, who needs to understand it if he is to play his part happily and wisely in our present civilization. Educated people emerge from school and college with little sympathy for science. Some boast shamelessly, later on, "I had a science course but I never made much of it." Science is considered abstruse and difficult or else a little crazy. Scientists are regarded as wizards with mysterious knowledge which they hand out either reluctantly or overfluently. Even high school science teaching supports this view by dazzling students with wonderful revelations and then discouraging them with powerful terminology.

Admittedly, this is too sweeping a condemnation. Yet how many of us believe that standard college courses (such as freshman physics), make the best contribution to a nonscientist's education? How many think that such courses alone give the best training to those who teach high school science to a new generation? At best such courses are interesting at the time; but their material is easily forgotten or muddled and they give little lasting benefit. At worst they produce bewilderment and dislike. Such results were sad in an earlier generation; now they are dangerous. The general student needs and deserves science courses that are an end in themselves, courses that give him an understanding of science.

In recent years, there has been growing concern for general education courses in college to provide a civilized intellectual background in an undergraduate's education. In the field of science new courses are being planned and some have started—including a few started long ago by far-seeing colleges. Scientists emerged from the war more concerned than ever over the barriers between them and laymen. The old claim that every educated man should know some science seems less important than the new one that every educated man should *understand* science well enough to work with scientists, perhaps to take something of science into his own life.

Now with general education courses being planned and tried, serious questions are being asked about them, not just by science teachers or college presidents or professional educators, but by all who have the good name of science at heart. Each reader of this paper should pause and ask himself: What do I want my children or my neighbors' children to gain from their science courses? What do I want both the future governors and the common man of the next generation to learn of or about science? Facts and laws? Or a friendly feeling towards science and scientists, and a delight in reading scientific books? Most of us, reflecting on such questions, find ourselves asking for teaching that will give genuine understanding as well as factual knowledge, perhaps at the expense of some factual knowledge—the making of new science courses for general education comes with an urgency that justifies drastic measures.

Since a number of new science courses have been started, those responsible for them are anxious to discuss aims, methods, and progress with others working on similar courses. The present article reports informally on two such conferences, one at the Princeton Inn in 1947 and one at the Lamont Library at Harvard in 1949. Both were initiated by President Conant of Harvard, Dean French of Colgate, and Dean Taylor of Princeton. The conferences themselves were small, informal gatherings—more or less accidental assemblages of people with strong interests in the new science courses.[1] They were limited to small numbers by considerations of cost and by the need for a small discussion group. This article relates mainly to the first conference, discussing the need for new science courses in college, their aims, and their construction.[2] The second conference continued the general discussions and held sessions concerned with the role of the historian of science, the relationship between the new courses and studies in social sciences, and the training of teachers. In our discussions it appeared that many standard courses in biological science are already reasonably humane, already trying to achieve the new aims. The physical scientists had guiltier consciences. So this article applies more particularly to the physical sciences.

ORTHODOX COURSES AND NEW COURSES

In many colleges, the only science courses available for nonscientists are orthodox courses in single sciences, originally designed to provide a sound foundation for further courses in the same science. Nonscientists take these courses, under university rules enforcing broad general programs or through their own interests and choice. The emphasis in these courses is mainly on content rather than on ideas or scientific method, and there is not enough time to give thorough understanding. Their use for general education has been defended on the grounds that a thorough learning of facts and principles does give an understanding of science; that the discipline of hard study is good in itself; and that routine work in classroom and laboratory gives training in scientific method which will spread to other studies and other activities in the student's life, making him more scientific.

When we judge such courses by their practice we find them crowded with material, particularly in the physical sciences; and when we judge them by their results we find they do not turn out many general students with a sympathetic understanding of science. So we turn to planning new courses with two special characteristics: (1) they are ends in themselves, intended for students who will study no more science, except in their own reading in later life; (2) they aim at producing sympathetic nonscientists who understand something of the nature of science, who feel they know what scientific work is like and what scientists are like, who have seen experiment and theory and critical argument used in building a structure of knowledge.

TRANSFER OF TRAINING

Our psychologist colleagues, however, give educators a serious warning about hopes that training given to a student in a science course will spread to other activities—hopes that one intellectual activity can sharpen the mind, or improve its ability for some other activity. Just such hopes have been used to defend the discipline of an orthodox course. And just such hopes lure all of us into planning to do *great things with new courses, such as make people* more scientific. Before we condemn orthodox courses or plan new ones, we need an answer to this key question: Will students transfer training, in some skill or habit or the use of some idea, from a science course to other studies or to life in general? If the answer is *no*, our new schemes offer little promise as part of general education. If the answer is *yes* our hopes should be grand.

In the past, educators placed great value on courses in classics, history, mathematics—in fact, on most of higher education—because they took it for granted that training in one field would transfer to many other fields and be retained as part of the student's general culture. Classics, it was claimed, trained students' minds and made them develop into scholars. In this respect, educators seem to have risked some confusion between *post hoc* and *propter hoc*—we might suspect the classical scholars had the intellect to succeed anyway. Since early this century there have been doubts about the hoped-for transfer. At first, experimental investigations said *no* to our key question; then later studies showed that transfer can occur to some extent. It certainly does not take place as easily as educators and the general public hoped. As one example, consider scientists themselves: are they better for their studies, tidy and systematic in their general life, critical and unbiased in their general thinking?

If transfer does not occur at all, higher education seems almost worthless, except for specialized professional training. Fortunately there is some transfer—language teaching can improve intellectual skills, mathematics can give a sense of form or provide training in careful argument, and so on—but *only under certain favorable circumstances.* These favorable circumstances[3] seem to be:

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[1] The conferences were peculiar in the one-sidedness of their personnel. Practically everyone there was already in favor of the new courses. It was like a bench of bishops meeting to discuss some general issue—perhaps it would be fairer to say a meeting of ministers of many faiths gathered to consider some common project. With this select clientele there was plenty of discussion but little straining of argument across major differences of ideals. The speed with which we could clarify our ideas and discuss methods was amazing. As a form of conference to help progress, this kind of gathering deserves strong recommendation; and I hope that conferences constructed similarly will be sponsored in many parts of the educational field. Professional societies and universities might find this difficult—the limited invitation would seem undemocratic—but here is a magnificent chance for foundations, which can issue a limited number of invitations to people who will come ready for profitable discussion.

[2] Accounts of some of the courses discussed have been published in *Science in general education*, edited by Earl J. McGrath (Wm. C. Brown and Company, Dubuque, Iowa, 1948).

I. The more there is in common between the field of training and the field to which we wish it to transfer, the greater the likelihood of transfer. There need to be common elements, which may be elements of material or method or ideals. For example, if we train a student to weigh accurately in a physics laboratory, it is almost certain that this training will transfer to another physics laboratory and he will weigh the more accurately there; it is moderately certain that he will carry his good training to a chemistry laboratory; much less likely that he will carry it to any weighing he does in his own kitchen or in his business; and it is very unlikely that the training in accuracy will reappear as a habit of being accurate in other activities. Another example: training in argument learned in geometry is likely to be transferred to later geometrical studies, not very likely to be transferred to work in physics, unlikely to help the student to think critically about arguments in newspaper advertisements, and very unlikely to make him a better economist. (We can modify the gloomy doubts expressed in these examples by attending to conditions II and III.)

II. Consciously seeking transfer may help transfer. We should encourage the student to review his gains in the field of study; then we should point out their applicability to other fields. We should even urge him to look for chances of transfer and remind him that unless he transfers some of his gains to his general life, our course will be of little lasting value. (We ask the student an intellectual version of the question that is put to a child: "Now Johnny, if I *give* you a tennis racket, will you *use* it?")

III. An almost essential lubricant for transfer is emotional attachment—the extent to which the student associates feelings of enjoyment, interest, and inspiration with his studies. The more he enjoys his science and is inspired by its skills and methods, the more he likes discussing its philosophy, the more likely he is to retain and transfer it. Thus, to return to our examples, a student who develops a delight in accurate weighing, making accuracy almost a minor ideal, may well carry the techniques and attitude of seeking accuracy far and wide in his activities, particularly if he has been made aware of the possibility and value of this wide transfer. The student who develops skill in geometrical argument and feels inspired by the method may well become the clearer lawyer or cleverer economist by the transfer of some of that training.

IV. It has been suggested that ease and amount of transfer increase with increasing general intelligence. This seems reasonable in the light of the other requirements. If this is true, the brightest students should profit most from courses in general education.

We now return with gravely increased doubts to the orthodox science course, in which the student is carried through topic after topic, learning things for examination purposes, without much time to consider or discuss or even to think about the nature of science. He does not develop an ideal of being scientific. The discipline of a physics course crammed with facts and principles, derivations and problems, may teach him physics but it offers poor hopes of transfer. So those of us who want to give students an appreciation of science, as well as some knowledge of it, seek courses in which we cover less material and have more time for other uses in the course. If students are to learn about scientific method they will need more time to study the harder parts of the content carefully so that they understand what they learn—a headache over difficult material treated too fast would be a poor basis for transfer. There must be time for student discussion, for careful reading and clear teaching, for historical analysis, for arguments and for expositions of the nature of science; above all time for students to turn around often and look back on the way they have traveled, trying to understand what it is all about instead of merely knowing facts or rules soon to be forgotten.

THE NEW COURSES

Realistic Aims. Turning the comments on transfer towards our aims for new courses, we again meet doubts. We doubt if we can cultivate general abilities or "train the mind." We doubt if we can give a complete conspectus of the basic principles of the physical and biological world, their implications for human welfare, and their influence on the development of thought and institutions, except a short-lived one that fades after the examination. We doubt if we can train critical thinkers—at best we can encourage critical thinking and hope for some transfer, if we plan for it. We are even doubtful about training students in scientific method with serious hopes of transfer; this seems to be asking too much. However, by leading them through a variety of scientific methods we may give them an appreciation of science which will transfer. Aims such as making students understand what science is like, and what scientists are like,[4] are more realizable, we believe, and many of us would be well satisfied with moderate success in these alone. Thinking of transfer from classroom to later life, we are tempted to transpose the word *like* in these aims and say, "to make students like science, and like scientists." If they do not enjoy their acquaintance, it is likely to be a brief one.

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[3] A useful 8-page report on this matter was published in 1930–31 by the British Association for the Advancement of Science. In that "Report on Formal Training" Prof. Cyril Burt wrote:

> A common element is more likely to be usable if the learner becomes clearly conscious of its nature and of its general applicability; active or deliberate transfer is far more effective and frequent than passive, automatic or unintentional transfer. This seems especially true when the common element is an element of method rather than of material, an ideal rather than a piece of information.

And Prof. F. A. Cavenagh wrote:

> It thus appears that this transfer exists, and that it can cut both ways. If education consists in "what remains after we have forgotten all we learnt" it may be no more than a dislike and contempt for any serious mental pursuit, for anything "high-brow." On the other hand, it may mean activity of mind and the capacity for finding interest in any task, and for constantly increasing the circle of one's interests.

Content. The new courses should mediate between the layman and the scientist, between a classical culture and a scientific civilization. They cannot do this just by pouring in scientific information or formal training. They must try to give a sympathetic understanding of science and the way scientific work is done. To make this understanding a lasting part of people's culture is a huge task. In a one-year course we can give only glimpses of it; and to do so will mean omitting at least half the orthodox course content.

We need have no fear that the new courses will lose all content and become easy talks about science. To achieve our aims we must deal with solid scientific material. Though we remove half the topics of an orthodox course, students may learn more rather than less in studying the rest more carefully, and may remember more material some time after the course. We can choose the material we keep and tie it together in such a way that they really have a chance to learn what science is like—and to like it. With an understanding of the nature of science they should be able to look up facts in books and they are likely to retain a lifelong interest in scientific reading.

THE BLOCK-AND-GAP SCHEME

In the conferences, we found a common element in all our schemes for new courses: the reduction of content to a smaller number of topics which are to be treated carefully as samples of scientific work.

To make discussion of schemes easier, I suggest the descriptions and names shown in Fig. 1 for various types of science courses. Let us represent the field of scientific knowledge by a table $ABCDD'C'B'A'$, containing a vertical column for each science. (For example $BCC'B'$ represents physics. I shall use physics as my example but another science would do just as well.)

The orthodox courses, labeled alpha and beta, proceed straight down a column, covering subject matter as thoroughly as time and the students' preparation permit, usually trying to lay a foundation for later courses. Some colleges offer several such courses for students with different preparation or interests. Of these, beta is a standard freshman course. All the important topics are treated in turn, often with little time to show their consequences or their interrelations. History may be mentioned but it is not discussed and certainly not brought to life. Beta is well packed with content. (In physics courses of this kind, problem-solving involves many arithmetical substitutions but contains some algebraic argument and derivations.)

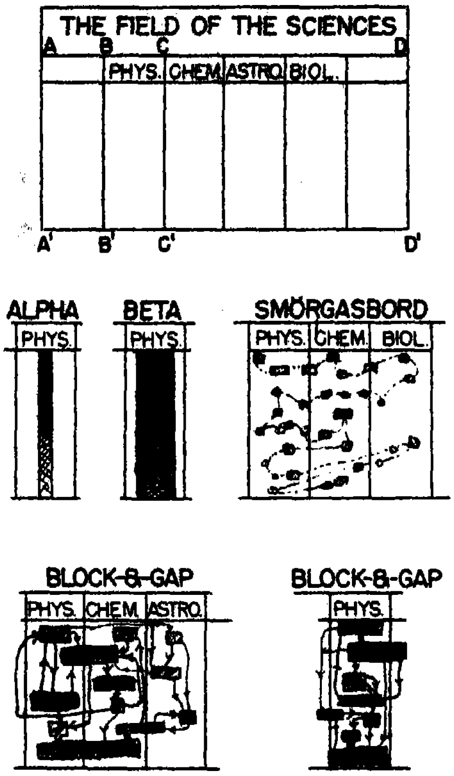

FIG. 1. Subject matter in science courses.

Alpha is a "thin" or easy course which begins at the beginning and mentions topics thoroughly but avoids the hard parts of the treatment. (In physics, such courses are often recommended for students who have not studied physics before, and they are sought by many premedical students. They seem hard enough to their customers, but to their instructors they often seem too easy and too dull. In tests, easy numerical problems are more common than derivations involving argument. The student's real understanding is not inquired into.)

To meet the needs of general education, some have suggested and tried a survey course running all over the field of several sciences, mentioning as many topics as it can. Some people believe this kind of course gives the student valuable acquaintance with the sciences. Most of us condemn it as giving a useless smattering of facts with no time for discussion or real understanding. We can draw a tenuous line connecting the topics, but such continuity has little educational value. I have labeled this the "smörgåsbord course." (The title "survey course" is easily misunderstood.) It is doubtful if this wild rush through many topics meets the needs of general education. Besides being too superficial, it makes science seem a glamorous wonderland of facts and names, announced by the wizard-scientist—a damaging piece of negative teaching.

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[4] In their work and in its effect on other people, not in their personal lives.

Putting into a diagram our prescription of less subject matter treated more carefully, I have sketched a scheme which I call a block-and-gap course. The blocks represent the chosen topics. They are taught thoroughly (so that the blocks are *dense*) and their background is explored (so that the blocks are *extensive*). Connecting the blocks are discussion lines along which flows the lifeblood of the course: historical studies, arguments about experiment and theory, ideas and information carried from one block to another, and thence, enriched, to still another or back to the first one—showing the organic structure of science. The gaps are essential; they reduce the content of the course so that there is time for discussion, time to see interrelationships, time for ideas to sink in, and time for the student to look back and reconsider.

Blocks may be chosen from a single science or from several sciences. In working practice, these two kinds of block-and-gap course do not differ greatly. There are those who insist that the methods of the different sciences differ so greatly that we should take samples from all sciences. But in a one-year course we might lose more by such diversity than we gained.

The block-and-gap scheme is a mere artifice to express general policy. It does not say what blocks should be chosen, nor does it show how they should be treated. Each group of teachers should choose its own set of blocks—the conscious effort involved contributes to the health of the course. Those starting a course would be unwise to copy someone else's choice; very unwise to choose too many blocks and thus return to a beta course.

TREATMENT OF BLOCKS

At the conferences we seemed agreed on the restriction of content to a few blocks, on the insistence that the blocks be treated thoroughly—more thoroughly than in a beta course—and on the importance of discussions, relating the blocks and commenting on them. But over the great question of how the blocks should be treated there was no general agreement. Probably, if we keep our attention fixed on our newly emphasized aims, we may use any treatment that fits the interests of staff and students. The history of the growth of a piece of science makes the science itself seem clearer. So we expect historical treatment to be useful. To some students, scientific work remains unreal unless they try it themselves; so we find laboratory work advocated—without the deadening effect of cookbook instructions. Ordinary teaching methods, such as expounding material and arguments in lectures, can be directed towards our new aims; so we meet pleas for saving time and money by lectures. Here is a list of some of the methods being tried:

Case histories. This is the method suggested by President Conant in his book *On understanding science.* In the hands of well-informed, enthusiastic teachers, this makes a marvelous course for certain kinds of students. Cases from many sciences can be selected, giving a much fairer account of scientific work and thinking than selections from a single science. Many of us believe that students emerge from such a course with a real appreciation and understanding of science. This course uses original writings and accounts of research by great scientists, very fully edited for students and accompanied by notes and reading from ordinary texts. Help is needed from professional historians of science, for editing material and for arranging the course, and it is to be hoped that colleges will establish faculty posts in the history of science for this purpose.

Study of original documents. This is a more extreme method, which encourages students to read original scientific writings very critically. Like the method just described, it needs good translations and reprints, many of them not yet available. Used alone, it is a slow method and probably should be combined with other methods, such as laboratory work.

Courses in the history of science by qualified historians. Excellent in themselves, such courses probably deserve to be preceded by a course in science and are better given in a special department. Conference members doubted that such courses would meet their aims for the general student, but felt they were almost essential in the preparation of future science teachers.

Orthodox presentation. This method makes use of lectures and laboratory work, etc., in the orthodox way, but with a new spirit. It is speedy and clear but lacks a certain needed flavor of genuineness unless combined with some historical treatment. Laboratory work is thought by many to be essential but it is costly and requires instructors who will be patient and silent and refrain from urging students to "get the right answer." The business of the laboratory is to give students close contact with scientific work, to make them aware of its difficulties, as well as its delights.

The same sense of reality may come from careful study of case histories, so in that course laboratory may be unnecessary—the laboratories of great scientists are brought into the students' library.

TEACHERS

What teachers are needed for such courses? Ideally we need a group trained in several sciences and in the history of science and in philosophy, people with special interests, perhaps with special teaching skills. Actually we find we can do well enough with a group of teachers picked from the usual science faculty, picked for their sympathetic interest in such courses. With the will to make the course succeed, young teachers learn in a few months to run classes and laboratories. Frequent staff conferences are needed, but then the discussions are far more interesting than routine staff meetings of a beta or alpha course. Out of the new courses themselves will come teachers for the next generation of new courses. For these new teachers we can advocate training in the history of science and in philosophy as well as orthodox subject matter in several sciences.

INTEGRITY

However the blocks and gaps are treated, we need all through the course a certain quality of intentness and relevancy. We need to be intent on the future of the course and on the past. Each block, reasonably complete in itself, must fit with other blocks, both use them and be useful to them in showing the structure of science. We should be intent on showing the growth of science from empirical knowledge extracted inductively to knowledge built into a structure of theory tested by experiment. We should make sure that reading and laboratory work and examination questions are relevant, above all in their attitude. We must aim directly at our goals, so that students can see and appreciate them.

Consider the teaching of scientific method as an example. Simply listing "method" in our program does not assure success. Routine drill in scientific procedure will do little good. Preaching at students a unique scientific method (devised by Francis Bacon) gives a stultified picture of scientific procedure which they may rightly reject as unreal. We should do better to have them find that science uses a variety of apparatus and techniques and then see that a problem can be investigated from several points of view—thus finding, in these senses, many scientific methods. Finally we may be able to show there is a single underlying method: the way in which scientists build up a sense of assurance or validity about scientific results as they proceed from empirical knowledge towards established theory. If we aim intently at these stages of understanding we may carry students with us.

I call this essential quality of intentness and relevance *integrity,* (with a slight flavor of integration). Each item in the course must be true to itself and true to the rest of the course and its aims. Without integrity, a block-and-gap course, run carelessly with a patchy mixture of topics, will be a failure—a tepid cafeteria meal. With integrity, we believe the new courses can do great things and are already succeeding in some measure, so that their students *will* maintain the good name of science.

Preview of the 116th Meeting, AAAS

New York City, December 26–31, 1949

General Information

Seventy-nine Association sections, affiliated and associated societies, and several guest organizations will present programs at the Sixth New York Meeting. Although in this respect it will be the largest convention in the Association's 101-year history, it will also be one of the most convenient. Nearly all the sessions are closely grouped in the hotels of New York's "Pennsylvania Zone." Related societies have headquarters in the same hotel, and the integrity of each society's sessions is assured. All of the hotels—the Statler, New Yorker, McAlpin, Governor Clinton, and Martinique—are within two blocks of the Pennsylvania Station and each other.

For those societies that prefer meeting in academic classrooms or laboratories, sessions are scheduled at Columbia University, only 15–20 minutes distant on the IRT Broadway-Seventh Avenue subway. The Biologists' Smoker is at the American Museum of Natural History, a short ride on the Eighth Avenue subway. The administrative officers of the AAAS believe that both the advantages of individual meetings and the many advantages of a large diversified meeting will be realized.

Space arrangements for the meeting were made possible by the cooperation of the New York Convention and Visitors Bureau, the sales managers of the hotels mentioned, and the administrators of Columbia University and the American Museum of Natural History. The Manhattan Center (next door to the New Yorker) was engaged by the American Sociological Society for its daytime sessions, but in no other instance was it necessary to pay for meeting rooms. The Association is further indebted to the New York Convention and Visitors Bureau for the aid of its experienced housing bureau and will use its professionally trained registration personnel at nominal expense. Commitments for a block of 3,500 sleeper rooms with accommodations for nearly twice that number of people were made by the Penn Zone hotels. Confirmations have been made promptly, often within a week. Except for the usual heavy demand for single rooms, there are plenty of hotel rooms available; if necessary, additional hotels near the Penn Zone can be utilized.

At this writing, there has been no exact count of papers to be read, but it exceeds 2,000. The General Program of more than 800 pages has already been mailed to those who registered in advance—between four and five times as many as the advance registrants at the Chicago Meeting of 1947. There is still time to register in advance if communications are received in Washington by 5: 00 p.m., December 12; please see the coupon in this issue. After that date, please register upon arrival. There will be registration facilities in *each* hotel, open daily from 8: 30 a.m. to 6: 00 p.m. The Main Registration-Information Center, on the 18th floor of the Hotel Statler—where the Visible Directory of Registrants, the AAAS New Member Service, the AAAS Science Theater, and the Annual Science Exposition will also be located—will be open each evening until 9: 00 p.m. The Main Registration-Information Center is the only source for supplementary literature, including 1) a free map and directory of points of interest in New York City, 2) special announcements, 3) descriptions of tours, 4) discounted tour tickets to the Empire State Building Observatory, Radio City, etc., 5) free radio broadcast tickets, and the like. Registrants should call for these at their convenience. Each advance registrant should bring his General Program (since another cannot be furnished), his registration receipt, and his convention badge to the Meeting.

This year, the Association no longer is *urging* society officers to have their session chairmen attempt to make registration mandatory, for this is awkward and inconvenient. Yet it is hoped that each person who attends the 116th Meeting, or any session of it, will realize that the AAAS registration fee—$2.00 for members, $3.00 for nonmembers—intentionally has been kept low to encourage attendance, especially by science teachers and students, and these fees are absolutely necessary to pay for the general expenses of the Meeting. The great majority of the participating societies have voted for the plan whereby the AAAS assists each society with its projection costs according to a formula based upon the average percentage of registrants at a society's sessions and the average percentage of AAAS membership. (Society A, with 90 percent registrants at its sessions, and 90 percent of its membership also members of the Association, will have 90 percent of its projection costs paid by the AAAS; Society B, with 50 percent registrants at its sessions, and 10 per cent of its membership also members of the Association, will still have 30 percent of its projection costs paid for by the AAAS.) Thus, each person who registers helps his own society. Presiding officers at sessions have the responsibility of estimating the percentage of nonregistrants, and so each registrant should wear his badge.

The following events are open only to registrants: The AAAS Reception, the AAAS Science Theater, the Biologists' Smoker (by an overwhelming vote of the biological societies), and free admission to the Museum of Modern Art and the D'Oyly Carte film production of *The Mikado*.

Reservations for hotel rooms may be made until almost the last day—please see the hotel reservation coupon in this issue. Telegrams or telephone calls are advisable after December 18. Those who do not make advance reservations, and find accommodations exhausted at a particular hotel, will be given help in finding a room—either by the desk clerk or by the Association's Information Center.

General Headquarters

The Hotel Statler (formerly the Hotel Pennsylvania), just across Seventh Avenue from Pennsylvania Station, is the official Headquarters of the AAAS; it is where the Council of the Association will meet. The Press Rooms are located on the South Mezzanine: Press Releases and Authors' Abstracts, Conference Room No. 7; Radio and Television arrangements, Local Publicity Committee, Conference Room No. 8. The Main Registration, Information Center, Visible Directory of Registrants, New Member Service, the Annual Science Exposition, International Photography-in-Science Salon, and the Science Theater, with its almost continuous showing of the latest scientific films, are all in the Penn Top of the Hotel Statler. The Penn Top is readily reached by express elevators.

Headquarters of the Sections of the AAAS and the Participating Societies

Hotel Statler (Seventh Avenue between 32nd and 33rd Streets): AAAS Sections B, C, F, M, N, Nm, Np; zoological societies, viz., American Society of Parasitologists, American Society of Protozoologists, American Society of Zoologists, Society of Systematic Zoology; American Microscopical Society, American Society of Naturalists; *Newark College of Engineering*; American Dietetic Association; Beta Beta Beta; National Association of Science Writers; National Geographic Society; Scientific Research Society of America; Sigma Delta Epsilon; Society of the Sigma Xi.

Hotel New Yorker (Eighth Avenue between 34th and 35th Streets): AAAS Sections E, H, I, L, Q; American Geographical Society of New York, Association of American Geographers, Geological Society of America; AAAS Cooperative Committee on Teaching of Science and Mathematics; the science teaching societies, viz., American Nature Study Society, National Association of Biology Teachers, National Council of Teachers of Mathematics, National Science Teachers Association, Federation of Science Teachers Associations of New York City, Society for Research in Child Development; Alpha Kappa Delta, American Farm Economic Association, American Sociological Society, Rural Sociological Society; American Philosophical Association, Philosophy of Science Association.

Manhattan Center (34th Street, next to Hotel New Yorker): Meeting rooms for the *morning and afternoon* sessions of the American Sociological Society.

Hotel McAlpin (Broadway [Avenue of the Americas] between 33rd and 34th Streets): AAAS Sections G, Nd, O; the plant science societies, viz., American Bryological Society, American Fern Society, American Society of Plant Physiologists, American Society of Plant Taxonomists, Botanical Society of America, Mycological Society of America, Phycological Society of America, Torrey Botanical Club; New York Section, American Institute of Electrical Engineers; American Institute of Biological Sciences.

Hotel Martinique (Broadway and 32nd Street): American Phytopathological Society.

Hotel Governor Clinton (Seventh Avenue and 31st Street): AAAS Sections A, D, K; American Mathematical Society, Institute of Mathematical Statistics, Mathematical Association of America; American Society of Human Genetics, American Society of Limnology and Oceanography, Biometric Society, Ecological Society of America, Genetics Society of America, Society for the Study of Evolution; Academy of World Economics; Metric Association; Alpha Epsilon Delta; Phi Kappa Phi; Pi Gamma Mu.

Registration

Main Registration and Information. The Main Registration and Information Center is located in the main corridor of the 18th floor of the Hotel Statler, which is quickly reached by express elevators to the Penn Top (marked 10–18). It is open from 8:30 a.m. to 9:00 p.m. daily from Monday, December 26, till Saturday, December 31, when it closes at noon. Badges and General Programs may also be obtained at all other registration desks, but the Main Registration is the *only* place where supplementary literature, free maps of the city, broadcast tickets, specially discounted tour tickets, etc., are available to registrants. *Advance registrants,* who received their programs and badges prior to the meeting, and those who register in their own headquarters hotels, are urged to visit the Main Registration at any convenient time to receive these items.

Supplementary Registration Desks. For the convenience of those attending the 116th Meeting there are supplementary registration desks in all the Peen Zone hotels, open 8:30 a.m. to 6:00 p.m. daily, Monday, December 26, through Friday, December 30, located as follows:

Hotel Statler—first mezzanine (opposite front entrance).
Hotel New Yorker—mezzanine.
Hotel McAlpin—first mezzanine.
Hotel Martinique—mezzanine.
Hotel Governor Clinton—main lobby.

On the evening of Thursday, December 29, upon the occasion of the Biologists' Smoker, 9:00 p.m. till midnight, there will be special registration facilities at the American Museum of Natural History—since this event is open only to registrants.

Registration Fee. The registration fee is $2.00 for members of the AAAS, for *bona fide* students, and for a wife or husband of a registrant; it is $3.00 for all others. Each registrant receives a receipt, a Convention Badge, and the General Program—the only publication containing the programs of all the 16 AAAS sections and the 63 participating societies.

Society Meal Function Tickets. In general, tickets to the dinners, luncheons, or breakfasts of any society are obtainable only from representatives of that society and during the preceding sessions of the society. Any society, however, has the privilege of the use of an AAAS Supplementary Registration desk to serve as a ticket booth, provided that that portion is manned by a representative of the society. Experience has shown that it is much more satisfactory to all concerned for each organized meal function to be the responsibility of the society that sponsors it.

Visible Directory of Registrants. The Visible Directory is located in the Salle Moderne on the 18th floor of the Hotel Statler—quickly reached by express elevators to the Penn Top. It will be open at all times except from late in the evening till 8: 30 a.m. During the hours when the Annual Science Exposition is open, the Salle Moderne is entered from the Penn Top because of the need for traffic to move in one direction. The registration cards of all registrants are placed in the Visible Directory as soon as possible after registration. The arrangement is alphabetical. The cards of advance registrants are alphabetized to the second or third letter of the surname, since they were posted in Washington prior to the meeting. All other registration cards are filed only by the initial letter of the surname (thus Thorp may precede Tate, etc.). Registrants will find the Visible Directory invaluable in determining the convention addresses of friends attending the Meeting.

Mail, Telegrams, and Messages. Mail and telegrams addressed in care of the AAAS will be held at the AAAS Office on the 18th floor of the Hotel Statler. Every effort will be made to notify addressees listed in the Visible Directory, but the Association assumes no responsibility for the delivery of mail or telegrams.

Telephone and personal messages will be filed alphabetically in the AAAS Office on the 18th floor of the Statler.

Points of Special Interest—Tours, etc.

The map and directory of New York—available to all registrants and distributed only from the Main Registration-Information Center, 18th floor, Hotel Statler—displays and lists all principal points of interest on Manhattan Island.

In addition to the map and directory, a limited number of copies of ''Let's Go and See,'' a leaflet giving information about all museums, botanic gardens, etc., in New York City, will be available at the Main Registration-Information Center. While each of these institutions will welcome visitors, those listed below have made special arrangements for AAAS delegates, members of their families, and guests.

The Metropolitan Museum of Art (Fifth Avenue at 82nd Street). On Wednesday, December 28, the entire museum will remain open until 6: 30 p.m. especially for AAAS guests. No admission charge.

Museum of Modern Art (11 West 53rd Street). In addition to permanent collection, works of Paul Klee are on exhibition. Color film: *The Mikado,* produced by the D'Oyly Carte Company. Hours, 12: 00 noon–7: 00 p.m.; films shown at 3: 00 and 5: 30 p.m.

Museum of the City of New York (Fifth Avenue at 103rd Street). Hours, Tuesday through Saturday, 10: 00 a.m.–5: 00 p.m. The exhibit, ''A Hospital Bed,'' which traces the growth of hospitals in New York City, will be of particular interest to medical scientists. An electron microscope will be operated at special times for AAAS delegates.

American Museum of Natural History (79th Street and Central Park West). A cordial invitation is extended to all attending the AAAS Meeting to visit the American Museum of Natural History, not only upon the occasion of the Biologists' Smoker, Thursday evening, December 29, 9: 00 p.m. till midnight, but throughout the week. Hours: Sundays and Monday, December 26, 1: 00 p.m. to 5: 00 p.m.; other days, 10: 00 a.m. to 5: 00 p.m.

New York Zoological Society. Open house on December 26, 27, 28, and 29. Guided tours leave the Administration Building at 2: 00 p.m.—return at 4: 00 p.m. for tea. (See Local Travel Directions for how to get there.)

The New York Public Library (Fifth Avenue and 42nd Street). A special exhibit, entitled ''Science—Old and New,'' includes rare early science manuscripts and printed books leading up to recent books and periodicals, is located on the main floor near the Science and Technology Division.

* *The Brooklyn Botanic Garden.* Open House in the virus and tissue culture laboratories at 2: 00 p.m., Tuesday, December 27. Conservatories open 10: 00 a.m. to 4: 00 p.m. weekdays, 2: 00 p.m. to 4: 00 p.m. Sundays. (Take Seventh Avenue subway to Eastern Parkway-Brooklyn Museum Station.)

* *The Boyce Thompson Institute for Plant Research, Inc.,* Yonkers, New York. Open House on Friday afternoon, December 30. The Institute will provide bus transportation (at cost) which will leave the Hotel McAlpin at 1: 30 p.m.; and return about 5: 30 p.m. Registration for this trip may be made at the Main Registration-Information Center, 18th floor, Hotel Statler, until Friday morning.

INDUSTRIAL ORGANIZATIONS

International Business Machines Corporation. Guided inspection tours of the Selective Sequence Electronic Calculator between 9: 15 a.m. and 5: 15 p.m. each day of the Convention. At IBM World Headquarters, 590 Madison Avenue.

* *New York Telephone Company.* Bell Telephone Laboratories at 463 West Street, New York. Tuesday, 10: 00 a.m., December 27; Wednesday, 2: 30 p.m., December 28. One and one half-hour tours each day showing: developments in dial telephone and switch; automatic message accounting; other items in the field of communications development. *Long Lines Department,* 32 Avenue of the Americas (Sixth Avenue), New York. Inspection tours at 10: 00 a.m. and 2: 30 p.m. on December 27, 28, 29, and 30. One and one half-hour tours showing: long distance operating room; overseas operating room; overseas control office; teletypewriter exchange; radio and television broadcasting networks room.

* *Rockwood & Company* (chocolate manufacturers). Guided inspection tour of their plant at 88 Washington Avenue, Brooklyn, for a group of ten persons at each of the following times: 10: 30 a.m. and 2: 30 p.m. on December 27 and 28.

* *Consolidated Edison Company of New York.* One-hour tours of the Waterside Station, 708 First Avenue (near the site of the new United Nations Headquarters) at 10: 00 a.m. and 2: 00 p.m. on December 28 and 29.

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* These require advance registration of at least one day—at the Main Registration-Information Center, 18th floor, Hotel Statler.

Radio and Television

National Broadcasting Company, Inc. Reduced tickets for tour of NBC facilities at RCA Building, Radio City, available at Main Registration-Information Center.

WOR (1440 Broadway, New York City). Free tickets for radio and television shows available at the Main Registration-Information Center.

Other radio broadcast tickets will also be available.

Commercial Tours

Rockefeller Center Guided Tours, Observation Roof (30 Rockefeller Plaza). Reduced tickets available at Main Registration-Information Center.

Empire State Building, Observatory (Fifth Avenue and 34th Street). Reduced tickets available at Main Registration-Information Center.

Sight-seeing Trips in Motor Coaches. Consult the Information Center for tours to various parts of the city.

Tours Arranged by the Federation of Science Teachers Associations of New York City

A series of tours and visits has been arranged. For details consult the Federation's booth in the Hotel New Yorker.

Field Trip

On Friday, December 30, starting at 8: 30 a.m., there will be an all-day Field Trip, perhaps to Jones Beach, to study ecology and wintering birds. This trip, sponsored by the American Nature Study Society, will be conducted by Edwin Way Teale, Roger Tory Peterson, Allan D. Cruickshank, Richard H. Pough, E. L. Palmer, and Richard L. Weaver.

Those interested should register, *preferably well in advance,* at Parlor B, Hotel New Yorker, the headquarters room of the Society and point of departure.

Press Service of the Association

All persons who will deliver addresses or present papers at the New York Meeting are requested to provide the Press Service with 100 copies of abstracts of their papers. One hundred copies of *complete* manuscripts are required of papers presented by 1) officers of the Association; 2) officers and invited speakers that appear on the programs of the participating societies; and 3) any author whose paper has a particular news value. In general, most authors already have recognized the necessity for this and will have sent this material to the Association's Press Director, Sidney S. Negus, Medical College of Virginia, Richmond, Virginia, before December 15. If this has not been done, however, please send your abstract and/or complete manuscript to Dr. Negus. Starting December 20, and throughout the meeting period, abstracts and copies of papers should be delivered to Dr. Negus at the *AAAS Press Office, Conference Room No. 7, First Mezzanine, Hotel Statler.* This press room is equipped with typewriters, duplicating machines, bulletin boards, extra telephones, standard references, and special files. Dr. Negus invites all who are interested to call. (But please do not request information or material that is available at the Information Center and Main Registration in the Penn Top!)

In *The Scientific Monthly* for September, 1949, pp. 156–160, F. Barrows Colton, president of the National Association of Science Writers and a member of the editorial staff of the *National Geographic Magazine,* has an entertaining article "Some of my Best Friends are Scientists." The points of view of the experienced science writer and the researcher, who may be unaware of the public's legitimate interest in his scientific contributions, are contrasted. He says:

> It is probably safe to say that science writers understand scientists better than scientists understand science writers. But science writers are so important to science that scientists need to have some knowledge of their working methods and problems.
>
> In the process of writing about science, modern science writers not only are covering the news but are rendering a real service to science as well. . . . They perform an essential and specialized role. . . . [Their] audience, incidentally, includes *many* scientists who *cannot* possibly keep up with all developments outside their own fields.

The necessity for the general public to be kept informed of the results of the scientific research which it supports, directly or indirectly, is quite evident. Organized science and the individual scientist must have the understanding and maintenance of all. It is, of course, equally important that the advances of science be publicized with clarity and without sensationalism. The progress in this direction has been gratifying. It is in the interest of accuracy and completeness that science writers frequently wish to discuss points with authors. If biographical information or photographs are requested, each author should recognize in this an obligation to science. Between 120 and 150 science writers are covering this Meeting and all wire services will carry the stories they file—to the entire civilized world. At no other scientific meeting are the facilities for the dissemination of the most recent findings in science so complete as they are at the great, diversified meetings of the AAAS.

This year, not only is the Association fortunate in the continued service of Prof. Negus, immediate past president of the Virginia Academy of Science, but also in its Local Publicity Committee, headed by Robert Harron, director of public information at Columbia, and Hayden Weller, director of press relations, New York University, and composed principally of the experienced directors of publicity of New York's institutions of higher learning. This committee has worked all fall to publicize the 116th Meeting on their own campuses, in magazines, and throughout the city. It has been in sole charge of news reels, radio, and television. The *Radio Press Room in Conference Room No. 8,* on the first mezzanine of the Hotel Statler, will be in operation after December 12.

AAAS Prize Awards

The 22nd award of the AAAS $1,000 Prize will be made at this New York Meeting to the author of a noteworthy paper presented on a regular program of the meeting and representing an outstanding contribution to science. The generous donor of this award, which is administered by the Association, has expressed the wish that this prize be awarded to one of the younger scientists and that it shall not be divided among two or more scientists working independently or in collaboration. The prize is awarded upon the recommendation of a special Prize Committee whose judgment shall be final. No award was made in 1948; the winner in 1947 was Harrison S. Brown.

The Prize Committee for the New York meeting consists of George S. Avery, Jr., director, Brooklyn Botanic Garden, *chairman*; Hans T. Clarke, Columbia University, New York City; Lincoln V. Domm, The University of Chicago, Chicago, Illinois; Kirtley F. Mather, Harvard University, Cambridge, Massachusetts; and George B. Pegram, Columbia University, New York City.

It is virtually impossible to determine the relative merits of scientific contributions in wholly different fields, and, of course, not an easy task to single out contributions in any one field of science. The members of each year's Prize Committee must set their own standards for the evaluation of scientific work presented at an annual meeting of the Association. The secretaries of the sections of the AAAS and also of the societies participating are invited to assist the Prize Committee by their preliminary suggestions of one or more papers from the fields they represent for consideration by the Prize Committee.

It is not necessary that the prize winner be a member of the Association. All papers listed in the General Program, except presidential and vice presidential addresses and invited papers, are eligible for the AAAS Prize.

AAAS-George Westinghouse Science Writing Awards. For the past 30 years, a relatively small but increasing group of professional journalists have devoted most or all of their time to the interpretation of developments in science for the lay public. In 1941, the Association recognized the importance of sound reporting of scientific news by accepting as an affiliate the National Association of Science Writers, organized in 1934 in Washington, D. C. In 1945, in the belief that special recognition and encouragement should be given to those writers who have the grave responsibility of making science near and real to the layman, the Westinghouse Educational Foundation and the American Association for the Advancement of Science began the joint sponsorship of the AAAS-George Westinghouse Science Writing Awards. In that year a certificate was given. In 1946 the plan provided for an annual $1,000 prize for newspaper writing, and, in 1947, it was decided to include a similar award for science reporting in magazines of general circulation. The Foundation provides the funds for the administration of the program, and the AAAS administers the awards through a Managing Committee, appointed by the Association's Executive Committee. The Managing Committee for 1949 consists of Howard A. Meyerhoff, *chairman*; Roger Adams, President Elect of the Association; James A. Baubie, public relations director, Westinghouse Electric Corporation; Frank Carey, science writer, Associated Press; Watson Davis, director, Science Service; Charles N. Fry, publicity department, Westinghouse Electric Corporation; Morris Meister, principal, Bronx High School of Science; and Sidney S. Negus, AAAS Press Director, Medical College of Virginia.

The awards will be made on the recommendations of the 1949 Judging Committee, the members of which are: Henry R. Aldrich, secretary, Geological Society of America; Detlev Bronk, president, The Johns Hopkins University; Kent Cooper, executive director, Associated Press; John R. Dunning, Department of Physics, Columbia University; Clifton Fadiman, Book-of-the-Month Club; Rudolf Flesch, writer; and Edward Weeks, editor, *The Atlantic Monthly*. Dr. Meister is chairman of this committee.

Prize winners in 1948 were Frank Carey, for newspapers, and Florence Moog, for magazines.

Presentation of the 1949 awards will be made at a luncheon in the Keystone Room of the Hotel Statler, at 1:00 p.m., on Wednesday, December 28. Dr. Elvin C. Stakman, President of the AAAS, will be the guest speaker. Admission is by invitation only.

Annual International Photography-in-Science Salon—on exhibition in the Salle Moderne, 18th floor of the Hotel Statler. Prize winners in the Third International Photography-in-Science Salon, an annual competition for scientists and photographers, sponsored by *The Scientific Monthly* and the Smithsonian Institution, were announced on September 25, 1949.

Judges were Merle A. Tuve, Carnegie Institution, for the physical sciences; Walter F. Jeffers, Department of Botany, University of Maryland, for the biological sciences; A. A. Teeter, Charles Pfizer & Company, New York City, for chemistry; Emanuel Krimsky, Polyclinic Hospital, New York City, for the medical sciences; and Alexander J. Wedderburn, Graphic Arts Division, Smithsonian Institution, for photography.

The 175 prints, which were on exhibition at the U. S. National Museum, October 3–31, will be on view at the 1949 AAAS Annual Meeting. Afterwards the show will go on a tour of important museums and scientific institutions in this country and abroad.

Prize winners in the Black-and-White Division:

First: L. L. Marton, chief, Electron Physics Section, National Bureau of Standards, Washington, D. C.: "Electron-optical shadow method."

Second: Bernard Henry Mollberg, University of Houston, Houston, Texas: "Ventrosinistral view of dried chick embryo, plated with aluminum."

Third: S. B. Newman, Emil Borysko, and Max Swerdlow, National Bureau of Standards, Washington, D. C.: "Electron micrograph of thin section of cells in onion root tip."

Honorable Mention: José Oiticica, Jr., Rio de Janeiro, Brazil (Guggenheim Fellow at the U. S. National Museum, Washington, D. C.): "Male genitalia, ventral view, of *Citheronia mogya* Schaus 1920 (Lepidoptera, Citheroniinae).

Clyde T. Holliday, Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Maryland: "Cloud formations." (Photograph made from a V-2 rocket at White Sands Proving Ground.)

T. G. Rochow, American Cyanamid Company, Stamford, Connecticut: "Commerical sample, tri-sodium orthophosphate ('TSP')."

Charles J. Salat, Armour Research Foundation, Chicago, Illinois: "Calibration of a ball bearing by means of optical flats."

Cleo O. Worden, Laboratory of C. A. Zapffe, Baltimore, Maryland: "Fractograph of piezoelectric single crystal."

In the Color Division, the following won awards:

First: Charles D. Oughton and Eugene C. Ricker, Battelle Memorial Institute, Columbus, Ohio: "Xerographic developing process."

Second: Chester F. Reather, Carnegie Institution, Baltimore, Maryland: "Implantation of twelve-day human ovum."

Third: Thomas C. Poulter (third-time prize winner) and Walter Lawton, Stanford Research Institute, Stanford, California: "High-speed movies of colored meteorological balloons used with Poulter Seismic Method show interaction of shock waves in the third dimension."

Honorable Mention: D. H. Rowland, Carnegie-Illinois Steel Corporation Research Laboratory, Pittsburgh, Pennsylvania: "Polished and etched cross section of experimental galvanized coating on low carbon steel."

Rowland B. Stradling, U. S. Cast Iron Pipe and Foundry Company, East Burlington, New Jersey: "Photomicrograph at 200 diameters of titanium nitride in cast iron."

Albert C. Walker, Bell Telephone Laboratories, Murray Hill, New Jersey: "Quartz crystal grown at Bell Telephone Laboratories."

Established to encourage and extend the use of photography as a basic research tool, the contest will be continued in 1950. All entrants shall be actively engaged in scientific research, and all photographs must be taken for scientific purposes. Entries should be sent to the Editor, *The Scientific Monthly,* 1515 Massachusetts Avenue, N. W., Washington 5, D. C., November 1–27, 1950. Prize winners and other accepted entries will be shown at the Annual Meeting of the AAAS in Cleveland, Ohio, December 26–31, 1950, and at the U. S. National Museum, Washington, D. C., January 3–31, 1951.

Dates for showing the 1949 pictures may be arranged by writing to the Editor of *The Scientific Monthly.*

Theobald Smith Award in Medical Sciences. After a lapse of five years, owing to the war, the Theobald Smith Award in Medical Sciences, established in 1936 by Eli Lilly and Company, will again be given at the Annual Meeting of the AAAS.

The Award Committee this year, appointed by Gordon K. Moe, Secretary of Section N, consists of Malcolm H. Soule, University of Michigan, *chairman,* Maurice B. Visscher, University of Minnesota; Louis S. Goodman, University of Utah Medical School; and William B. Castle, City Hospital, Boston.

The award consists of $1,000 and a bronze medal, given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." An additional amount of $150 is available toward traveling expenses. The recipient must be less than 35 years of age on January 1 of the year in which the award is to be made, and a citizen of the United States.

Past recipients are: Robley D. Evans, Charles F. Code, Albert B. Sabin, Herald R. Cox, and Sidney C. Madden.

AAAS Business Sessions

The *Executive Committee* of the Association will meet for luncheon and a business session in the Administrative Secretary's suite at the Hotel Statler at noon on Tuesday, December 27. Dates and hours of subsequent sessions of the Executive Committee during the New York Meeting will be decided at this first meeting.

Two sessions of the *Council* of the Association are scheduled at the New York Meeting. The first will be held at 4:00 p.m. Tuesday, December 27, in Parlor 2, Hotel Statler; the second will take place in the same room at 4:30 p.m. Thursday, December 29.

The Council is the governing body of the Association. Although the actual transaction of AAAS business is entrusted to the Executive Committee of the Council, the Constitution stipulates that "Control of all affairs of the Association is vested in the Council, which shall have power to review and to amend or rescind its own actions and all actions taken by the Executive Committee or by other agents to whom powers are delegated by this Constitution or shall have been delegated by the Council. The Council shall enact such bylaws as it may deem desirable, each of which shall remain in force until amended or rescinded by action of the Council."

Because of the large number of affiliated societies participating in the New York Meeting, a record attendance is expected at both sessions of the Council. For this reason several important items of business have been placed on the agenda, among them:

1. Election of the President Elect for 1950.
2. Election of three members of the Executive Committee of the Council, two to succeed C. F. Kettering and Fernandus Payne, whose four-year terms end this year, and one to complete the unexpired term of Roger Adams, whose election to the Presidency of the Association has made him an *ex officio* member of the Executive Committee.
3. Method of nomination and election of the President Elect and Executive Committee members.
4. Revision of Bylaws of the Association (report of Committee, K. F. Mather, *chairman*).
5. Report on Council vote on
    a. Retention of membership grades of Member and Fellow.
    b. Starring of scientists in *American men of science.*
    c. Type of Association meetings.
6. Reports on Association affairs:
    a. Report from the Treasurer, W. E. Wrather;
    b. Reports from Committees: Cooperative Committee on science teaching (K. Lark-Horovitz, *chairman*); Committee on Affiliation and Association (M. H. Soule, *chairman*); Publica-

tions Committee (E. C. Stakman, *chairman*); Editorial Board (H. A. Meyerhoff, *chairman*).

7. New business. Members of the Council are requested to communicate new items of business that should be placed on the agenda to Howard Meyerhoff, Administrative Secretary, not later than December 19.

The *Academy Conference* will hold a session Friday morning, December 30, at 10:00 a.m. in Parlor A, Hotel New Yorker, and a second session Friday afternoon, at 2:30 p.m., in the same room. At the afternoon session there will be exhibits by high school students, including the prize winners of scholarships awarded by the International Business Machines Corporation. In the evening, the Academy Conference Dinner is scheduled at 6:00 p.m., the place to be announced. The speaker will be William G. Pollard, and his subject: "The Oak Ridge Institute for Nuclear Studies and the Atomic Energy Program in the Associated Universities."

The *Inter-Society for a National Science Foundation* will hold an open meeting on Tuesday morning, December 27, in the Keystone Room, Hotel Statler, at 10:30 a.m.

Local Committees

A complete list of AAAS Local Committees was printed in *Science* on November 4, p. 486 it will not be repeated here. The Honorary Reception Committee, headed by Governor Thomas E. Dewey and Mayor William O'Dwyer, includes some 80 heads of New York's institutions of higher learning, medical and technical schools, academies, institutes and foundations scientific in character, museums and local technical and scientific societies.

The Program

Full details of the individual programs of the 79 sections and participating organizations are in the General Program, now available to advance registrants. The Special Sessions and AAAS-sponsored Symposia appeared in *Science* on November 18, pp. 536 ff.; the program of the AAAS Science Theatre in *Science* for November 25, pp. 571 ff.

A synopsis of the program sessions, by days, follows:

Monday Afternoon, December 26

AAAS as a Whole

The AAAS Science Theatre, 18th floor, Statler, has its first showing at 2:00 p.m. (open only to registrants).

Annual Science Exposition, Penn Top and adjoining Salle Moderne, Statler, opens at 2:00 p.m.; closes at 6:00 p.m.

Anthropology

H[1] *Section on Anthropology*—2:30 p.m.; Session, Social Anthropology; Parlors F-G, New Yorker.

Monday Evening, December 26

AAAS as a Whole

Illustrated Public Lecture on Recent Advances in Nuclear Physics—8:00 p.m.; auspices of Scientific Research Society of America; Grand Ballroom, Statler.

Botanical Sciences

G4 *American Society of Plant Physiologists*—7:00 p.m.; Executive Committee Meeting; Parlor E, McAlpin.

G6 *Botanical Society of America*—8:00 p.m.; Council Meeting of Society; Room F, McAlpin.

Science in General

X5 *Scientific Research Society of America*—4:00 p.m.; Meeting of Governing Board; Parlor A, Statler. 5:00 p.m.; General Convention of Society; Parlor A, Statler. 8:00 p.m.; Illustrated Public Lecture on Recent Advances in Nuclear Physics; Grand Ballroom, Statler.

Tuesday Morning, December 27

AAAS as a Whole

Q, H, I, K, and N—9:00 a.m.; Symposium on Meeting the Needs of School Children; North Ballroom, New Yorker.

AAAS Cooperative Committee—10:00 a.m.; Symposium on Trends in Modern Science; Grand Ballroom, New Yorker.

Inter-Society Committee for a National Science Foundation—10:30 a.m.; Open Meeting; Keystone Room, Statler.

Mathematics

A1 *American Mathematical Society*—10:00 a.m.; Concurrent Session 1; Room 301, Pupin Laboratories. 10:00 a.m.; Concurrent Session 2; Room 329, Pupin Laboratories.

A2 *Institute of Mathematical Statistics*—9:00 a.m.; Session I-1, joint Session with the American Statistical Association; Governor Room, Governor Clinton.

Zoological Sciences

F1 *American Society of Parasitologists*—9:00 a.m.; Session; Georgian Room, Statler.

Zoological and Botanical Sciences

FG 10 *National Association of Biology Teachers*—8:00 a.m.; Executive Board Meeting; Parlor D, New Yorker.

FG 11 *Society for the Study of Evolution*—11:00 a.m.; Council Meeting; John Jay Dining Hall, Columbia.

Botanical Sciences

G1 *American Bryological Society*—8:00 a.m.; Breakfast Meeting; Marine Grill, McAlpin. 9:00 a.m.; Business Meeting; El Patio, McAlpin. 10:00 a.m.; Session; El Patio, McAlpin.

G3 *American Phytopathological Society*—9:30 a.m.; Council Meeting; West Room, Martinique.

G4 *American Society of Plant Physiologists*—9:00 a.m.; Concurrent Session 1, joint session with Physiological Section of Botanical Society of America (Session 5); Winter Garden, McAlpin. 9:00 a.m.; Concurrent Session 2, joint session with Physiological Section of Botanical Society of America (Session 6); Ballroom, McAlpin.

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[1] The key symbols in boldface preceding each event refer to the AAAS Sections and participating societies, as listed in the INDEX OF PROGRAMS near the front of the General Program, and as repeated in the detailed SECTION AND SOCIETY PROGRAMS—the main portion of this book. These programs should be consulted for speakers and titles of papers.

G5 *American Society of Plant Taxonomists*—9:30 a.m.; Symposium on Phytogeography of South America Part I, joint session with Systematic Section of Botanical Society of America (Session 7); Crystal Room, McAlpin.

G6 *Botanical Society of America*—9:00 a.m.; Session 1, Business Meeting of Society; Colonial Room, McAlpin. 9:30 a.m.; Concurrent Session 2, General Section; Colonial Room, McAlpin. 9:30 a.m.; Concurrent Session 3, parallel meeting of Microbiological Section and Mycological Society of America; Green Room, McAlpin. 9:30 a.m.; Concurrent Session 4, Paleobotanical Section; East Room, McAlpin. 9:00 a.m.; Concurrent Session 5, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 1); Winter Garden, McAlpin. 9:00 a.m.; Concurrent Session 6, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 2); Ballroom, McAlpin. 9:30 a.m.; Concurrent Session 7, Symposium on Phytogeography of South America, Part I, joint meeting of Systematic Section and American Society of Plant Taxonomists; Crystal Room, McAlpin.

G7 *Mycological Society of America*—9:00 a.m.; Business Meeting and Session; Blue Room, McAlpin. 9:30 a.m.; Session, parallel meeting of Microbiological Section of Botanical Society of America (Session 3); Green Room, McAlpin.

G8 *Phycological Society of America*—9:00 a.m.; Session; Room F, McAlpin.

Anthropolgy

H *Section on Anthropology*—9:00 a.m.; Symposium on Meeting the Needs of School Children, joint session of Sections H, I, K, N, and Q; North Ballroom, New Yorker. 9:30 a.m.; Symposium on Mind, Culture and Individuality, Part I; Parlors F-G, New Yorker.

Psychology

I *Section on Psychology*—9:00 a.m.; Symposium on Meeting the Needs of School Children, joint session of Sections I, H, K, N, and Q; North Ballroom, New Yorker. 9:00 a.m.; Session; East Room, New Yorker.

Social and Economic Sciences

K *Section on Social and Economic Sciences*—9:00 a.m.; Symposium on Meeting the Needs of School Children, joint session of Sections K, H, I, N, and Q; North Ballroom, New Yorker.

K4 *American Sociological Society*—Executive Committee Meeting; Parlors E-H, New Yorker. (Time not announced.)

K5 *American Statistical Association*—9:00 a.m.; Joint session with the Institute of Mathematical Statistics; Governor Room, Governor Clinton.

Engineering

M *Section on Engineering*—9:00 a.m.; Annual Business Meeting of Section; Parlor 1, Statler.

Medical Sciences

N *Section on Medical Sciences*—9:00 a.m.; Symposium on Meeting the Needs of School Children, joint sessions of Sections N, H, I, K, and Q; North Ballroom, New Yorker.

Education

Q *Section on Education*—9:00 a.m.; Symposium on Meeting the Needs of School Children, joint session of Sections Q, H, I, K, and N; North Ballroom, New Yorker.

Q1 *AAAS Cooperative Committee on Teaching of Science and Mathematics*—10:00 a.m.; Symposium on Trends in Modern Science, joint session of all science teaching societies affiliated with the AAAS; Grand Ballroom, New Yorker.

Q2 *National Science Teachers Association*—8:00 a.m.; Executive Committee Meeting; Parlor C, New Yorker.

Science in General

X1 *American Nature Study Society*—8:00 a.m.; Meeting of Board of Directors, Officers and Delegates; Parlor B, New Yorker.

X7 *The Society of the Sigma Xi*—9:00 a.m.; Executive Committee Meeting; Suite of the Society, Statler.

Tuesday Noon and Afternoon, December 27

AAAS as a Whole

Executive Committee—12:00 noon; Luncheon and Meeting; Suite of Administrative Secretary, Statler.

Council Meeting—4:00 p.m.; Parlor 2, Statler.

National Geographic Society—3:00 p.m.; Annual Lecture, Illustrated, sound film in color on Arnhem Land; Grand Ballroom, Statler.

Mathematics

A *Section on Mathematics*—2:00 p.m.; Address of Retiring Vice President, joint session with American Mathematical Society; Room 301, Pupin Laboratories.

A1 *American Mathematical Society*—2:00 p.m.; Joint session with Section A; Room 301, Pupin Laboratories. 4:00 p.m.; Tea given by Columbia University; Faculty House.

A4 *National Council of Teachers of Mathematics*—2:00 p.m.; Session and Demonstration—Working with Glass, joint meeting with National Science Teachers Association; Grand Ballroom, New Yorker.

Geology and Geography

E4 *National Geographic Society*—3:00 p.m.; Lecture and color-illustrated sound film on Arnhem Land; Grand Ballroom, Statler.

Zoological Sciences

F1 *American Society of Parasitologists*—2:00 p.m.; Session; Georgian Room, Statler.

F3 *American Society of Zoologists*—12:00 noon; Executive Committee Meeting; Parlor A, Statler.

Zoological and Botanical Sciences

FG1 *American Microscopical Society*—1:00 p.m.; Executive Committee Luncheon and Business Meeting; Parlor B, Statler.

FG5 *Beta Beta Beta*—12:15 p.m.; Luncheon and Convention Address; Oak Room, Martinique. 1:30 p.m.; Business session; Oak Room, Martinique.

FG8 *Ecological Society of America*—2:00 p.m.; Session on Plant Ecology, joint session with Botanical Society of America; Gold Room, Martinique.

FG10 *National Association of Biology Teachers*—2:00 p.m.; Teaching Aids from within the Classroom and Laboratory; North Ballroom, New Yorker.

FG11 *Society for the Study of Evolution*—2:00 p.m.; Session; Room 902, Schermerhorn Hall, Columbia.

Botanical Sciences

G1 *American Bryological Society*—2:00 p.m.; Symposium on *The Bryologist* and Bryology; El Patio, McAlpin.

G4 *American Society of Plant Physiologists*—1:30 p.m.; Concurrent Session 1, joint session with Physiological Section of Botanical Society of America (Session 4); Winter Garden, McAlpin. 1:30 p.m.; Concurrent Session 2, joint session with Physiological Section of Botanical Society of America (Session 5); Ballroom, McAlpin.

G5 *American Society of Plant Taxonomists*—2:00 p.m.; Symposium on the Phytogeography of South America, Part II, joint session with the Systematic Section of Botanical Society of America (Session 6); Crystal Room, McAlpin.

G6 *Botanical Society of America*—2:00 p.m.; Concurrent Session 1, General Section; Colonial Room, McAlpin. 2:00 p.m.; Concurrent Session 2, joint meeting of Microbiological Section and Mycological Society of America; Green Room, McAlpin. 2:00 p.m.; Concurrent Session 3, Paleobotanical Section; East Room, McAlpin. 1:30 p.m.; Concurrent Session 4, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 1); Winter Garden, McAlpin. 1:30 p.m.; Concurrent Session 5, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 2); Ballroom, McAlpin. 2:00 p.m.; Concurrent Session 6, Symposium on Phytogeography of South America, Part II; Joint meeting of Systematic Section and American Society of Plant Taxonomists; Crystal Room, McAlpin. 2:00 p.m.; Concurrent Session 7, Plant Ecology, joint meeting with the Ecological Society of America; Gold Room, Martinique.

G7 *Mycological Society of America*—2:00 p.m.; Session on Medical Mycology; Joint meeting with Microbiological Section of Botanical Society of America (Session 2); Green Room, McAlpin.

G8 *Phycological Society of America*—2:00 p.m.; Session; Room F, McAlpin.

Anthropolgy

H *Section on Anthropology*—2:00 p.m.; Symposium on Mind, Culture, and Individuality, Part II; Parlors F–G, New Yorker.

Psychology

I *Section on Psychology*—2:00 p.m.; Session; East Room, New Yorker.

Social and Economic Sciences

K4 *American Sociological Society*—2:00 p.m.; Executive Committee Meeting; Parlors E–H, New Yorker.

Medical Sciences

N3 *Alpha Epsilon Delta*—12:15 p.m.; Luncheon for all members and others interested in premedical education; Greeley Room, Governor Clinton.

Education

Q *Section on Education*—2:00 p.m.; Session; Parlor A, New Yorker.

Q2 *National Science Teachers Association*—2:00 p.m.; Session and Demonstration—Working with Glass, joint meeting with National Council of Teachers of Mathematics; Grand Ballroom, New Yorker.

Science in General

X1 *American Nature Study Society*—2:00 p.m.; Session, Nature Writing and Nature Books; Panel Room, New Yorker.

X6 *Sigma Delta Epsilon*—4:30 p.m.; Alumnae member's tea; Parlor C, Statler.

X7 *The Society of the Sigma Xi*—1:00 p.m.; Executive Committee Meeting; Suite of the Society, Statler. 4:00 p.m.; Annual Convention; Keystone Room, Statler.

Tuesday Evening, December 27

AAAS as a Whole

M and M1 *Section on Engineering;* and *Newark College of Engineering*—7:30 p.m.; Symposium on Nuclear Engineering, joint program; Parlor 1, Statler.

Annual Address of the Society of the Sigma Xi—8:00 p.m.; Illustrated Lecture: Evolution in the Tropics; Grand Ballroom, Statler.

Mathematics

A1 *American Mathematical Society*—8:00 p.m.; Meeting of Organizing Committee of the International Mathematical Congress; Room 4, John Jay Hall.

Zoological Sciences

F1 *American Society of Parasitologists*—7:00 p.m.; Dinner and Business Meeting of officers and members of Council; Parlor A, Statler.

Zoological and Botanical Sciences

FG 10 *National Association of Biology Teachers*—7:30 p.m.; Meeting of Board of Directors; Parlor D, New Yorker.

FG 12 *American Institute of Biological Sciences*—9:30 p.m.; Conference on Uniformity of Literature Citations; Colonial Room, McAlpin.

Botanical Sciences

G4 *American Society of Plant Physiologists*—7:00 p.m.; Plant Physiologists' Dinner, Presidential Address of Society, Stephen Hales Lecture; Gold Room, Martinique.

G5 *American Society of Plant Taxonomists*—7:00 p.m.; Annual Meeting and Dinner of Society, Presidential Address; Hunter College.

G6 *Botanical Society of America*—8:00 p.m.; Council Meeting of Society; Room F, McAlpin.

Psychology

I *Section on Psychology*—8:00 p.m.; Vice Presidential Addresses of Sections I and Q, joint session; North

Ballroom, New Yorker.

Engineering

M and M1 *Section on Engineering; Newark College of Engineering*—7:30 p.m.; Symposium on Nuclear Engineering, joint program; Parlor 1, Statler.

Medical Sciences

N4 *American Dietetic Association*—8:00 p.m.; Session; Governor Room, Governor Clinton.

Education

Q *Section on Education*—8:00 p.m.; Vice Presidential Addresses of Sections Q and I, joint session; North Ballroom, New Yorker.

Q2 *National Science Teachers Association*—7:30 p.m.; Board of Directors Meeting; Parlors F–G, New Yorker.

Science in General

X1 *American Nature Study Society*—8:00 p.m.; Annual Business Meeting, Informal Showing of Kodachromes; Panel Room, New Yorker.

X7 *The Society of the Sigma Xi*—8:00 p.m.; Illustrated Lecture: Evolution in the Tropics; Grand Ballroom, Statler.

Wednesday Morning, December 28

AAAS as a Whole

AAAS Cooperative Committee on the Teaching of Science and Mathematics—10:00 a.m.; General Session, joint meeting with all science teaching societies; Grand Ballroom, New Yorker.

AAAS Subsection Nm—9:30 a.m.; Symposium on Adrenal Cortex, Part I; Keystone Room, Statler.

Mathematics

A1 *American Mathematical Society*—9:30 a.m.; General Session; Room 301, Pupin Laboratories. 10:45 a.m.; Concurrent Session 1; Room 301, Pupin Laboratories. 10:45 a.m.; Concurrent Session 2; Room 329, Pupil Laboratories.

Zoological Sciences

F1 *American Society of Parasitologists*—9:00 a.m.; Symposium on the Physiology of Parasites; Gold Room, Martinique.

F2 *American Society of Protozoologists*—9:00 a.m.; Business Meeting; Parlor 1, Statler.

F3 *American Society of Zoologists*—9:15 a.m.; Symposium on Experimental Cell Research, joint session with Genetics Society of America; Grand Ballroom, Statler.

Zoological and Botanical Sciences

FG2 *American Society of Human Genetics*—10:00 a.m.; Session; Gramercy Room, Governor Clinton. Demonstrations, all day, Wednesday (and Thursday); Parlors F and J, Governor Clinton.

FG3 *American Society of Limnology and Oceanography*—9:30 a.m.; Special Session on Apparatus and Methods; Room 902, Schermerhorn Hall, Columbia.

FG8 *Ecological Society of America*—9:30 a.m.; Concurrent Session 1, Animal Ecology; Room 502, Kent Hall, Columbia. 9:30 a.m.; Concurrent Session 2, Plant Ecology; Room 515, Kent Hall.

FG9 *Genetics Society of America*—9:00 a.m.; Concurrent Session 1; Governor Room, Governor Clinton. 9:00 a.m.; Concurrent Session 2; Florentine Room, Governor Clinton. 9:15 a.m.; Concurrent Session 3, Symposium on Experimental Cell Research, joint session with American Society of Zoologists; Grand Ballroom, Statler.

FG10 *National Association of Biology Teachers*—10:00 a.m.; General Session, joint meeting with AAAS Cooperative Committee and all science teaching organizations affiliated with AAAS; Grand Ballroom, New Yorker.

FG11 *Society for the Study of Evolution*—9:00 a.m.; Symposium on the Role of the South Atlantic Basin in Biogeography and Evolution, Part I; Main lecture room, Brander Matthews Hall, Columbia.

Botanical Sciences

G1 *American Bryological Society*—9:30 a.m.; Joint Sessions all day with Systematic Section of Botanical Society of America and American Society of Plant Taxonomists; at New York Botanical Garden.

G3 *American Phytopathological Society*—9:00 a.m.; Business Meeting; Oak Room, Martinique. 10:30 a.m.; Business Meeting, Northeastern Division of Society; Oak Room, Martinique.

G4 *American Society of Plant Physiologists*—9:00 a.m.; Concurrent Session 1, joint session with Physiological Section of Botanical Society of America (Session 5); Winter Garden, McAlpin. 9:00 a.m.; Concurrent Session 2, joint session with Physiological Section of Botanical Society of America (Session 6); Ballroom, McAlpin.

G5 *American Society of Plant Taxonomists*—9:30 a.m.; Session, Business Meeting, Luncheon; Joint Meeting with Systematic Section of Botanical Society of America (Session 8); at New York Botanical Garden.

G6 *Botanical Society of America*—9:00 a.m.; Session 1, Business Meeting of Society; Colonial Room, McAlpin. 9:30 a.m.; Concurrent Session 2, General Section; Colonial Room, McAlpin. 9:30 a.m.; Concurrent Session 3, joint meeting of Microbiological Section with Mycological Society of America; Green Room, McAlpin. 9:00 a.m.; Concurrent Session 4, joint meeting of the Paleobotanical Section with the Society for the Study of Evolution; Symposium on the Role of the South Atlantic Basin in Biogeography and Evolution, Part I; main lecture room, Brander Matthews Hall, Columbia. 9:00 a.m.; Concurrent Session 5, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 1); Winter Garden, McAlpin. 9:00 a.m.; Concurrent Session 6, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 2); Ballroom, McAlpin. 9:30 a.m.; Concurrent Session 7, Botanical Teaching Section; Symposium on Basic Training for Specialization in Research; Blue Room, McAlpin. 9:30 a.m.; Concurrent Session 8; Business Meeting, Luncheon; Joint Meeting of Systematic Section, American Society of Plant Taxonomists, and

REGISTER NOW

for the New York Meeting of the AAAS

AVOID CONGESTION AND DELAY GET YOUR GENERAL PROGRAM EARLY IN DECEMBER

Registration in *advance* of arrival at the 116th Annual Meeting of the AAAS in the Pennsylvania Zone hotels of New York City, December 26–31, 1949, has so many advantages that we wonder why almost *everyone* doesn't take this simple step. For instance:

1. You avoid congestion and delay at the Registration Desks in the hotel foyers. All indications point to a record-breaking attendance since all of the Association's seventeen sections and subsections, and more than fifty societies, will have sessions; also this is the first meeting in New York City since 1928.
2. You receive the General Program early in December in ample time unhurriedly to decide among the events and the sessions of the societies that you wish to attend.
3. Your name and hotel address will be in the Visible Directory the first hour of the first day of the meeting, since it will be posted in Washington as soon as processed.
4. Advance Registrants will have the same privileges of receiving a map and directory of points of interest of New York City, literature, radio broadcast tickets, etc. At the convenience of Advance Registrants, these will be distributed from the Main Registration on the Penn Top of the Hotel Statler, the location of the Annual Science Exposition, the Visible Directory, and the Science Theatre. Admission to the excellent series of latest scientific films will be free to all Registrants.

This year, as a result of the vote of the biological societies, including the American Society of Naturalists, the sponsors, the Biologists' Smoker will be open only to regular registrants or those who pay a registration fee at the time.

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1. **Registration Fee enclosed:** (check one)

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Please mail this coupon and your check or money order for the fee, $2.00 or $3.00, to
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HOTEL RESERVATIONS

116th AAAS MEETING

New York City, December 26-31, 1949

The list of hotels and the reservation coupon below are for your convenience in making your hotel room reservation in New York City. Please send your application, *not* to any hotel directly, but to the Housing Bureau of the New York Convention and Visitors Bureau to avoid delay and confusion. The experienced Housing Bureau will make assignments promptly and the hotel will send a confirmation directly to you in two weeks or less. Mail your application *now* to secure your first choice of desired accommodations

THIS IS YOUR HOTEL RESERVATION COUPON

Miss Sylvia T. Peltonen, Manager
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Date of application ....

Please reserve the following accommodations for the 116th Annual Meeting of the AAAS:

TYPE OF ACCOMMODATION DESIRED

Single Room .... Rate ....

Double Room .... Rate .... Number in Party ....

Other .... Rate .... Sharing this room will be:

.... persons ....

(*Enumerate and attach list giving names and addresses of each person, including yourself*)

CHOICE OF HOTEL

First choice .... Second choice .... Third choice ....

DATE OF ARRIVAL .... DEPARTURE DATE ....

(These *must* be indicated)

SIGNED ....

ADDRESS ....

(Street) (City and Zone) (State)

Mail this now to the Housing Bureau.

Rooms will be assigned and confirmed in order of receipt of reservation.

Hotel will confirm directly in two weeks or less.

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HOTEL**	WITHOUT BATH		WITH BATH		Twin	3	4
	Single	Double	Single	Double	Beds	Beds	Beds
STATLER			$4.00 –$7.50	$6.50 –$10.50	$8.00 –$14.00	$11.00	$13.00
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McALPIN	$3.00 –$3.50	$5.00 –$5.50	$4.00 –$7.00	$6.50 –$10.00	$7.50 –$11.00	$9.50 –$12.00	$14.00 –$17.50
GOVERNOR CLINTON			$4.00 –$6.00	$6.50 –$8.00	$7.50 –$9.50	$10.50	$12.00
MARTINIQUE	$2.50 –$3.00	$5.75	$3.75 –$5.00	$6.00 –$8.00	$6.00 –$8.00	$9.00	$11.00

Suites range from $10.00 to $26.00; $10.00 to $18.00 at Martinique, $12.00 to $22.00 at New Yorker, $12.50 to $26.00 at Governor Clinton, $13.00 to $16.00 at McAlpin, and $15.00 to $17.00 at Statler.
The New Yorker charges $2.50 for an additional person per room; the other hotels $2.00.

*** New York City Hotel-room Tax of 5% is not included in this schedule of rates.**

**** A list of the headquarters of each society appeared in THE SCIENTIFIC MONTHLY for August, pages iv and v, and in Association Affairs, SCIENCE, August 26, page 220.**

American Bryological Society; at New York Botanical Garden.

G7 *Mycological Society of America*—9:30 a.m.; Session, joint meeting with Microbiological Section of Botanical Society of America (Session 3); Green Room, McAlpin.

G8 *Phycological Society of America*—9:00 a.m.; Symposium on the Culturing of Algae; Room F, McAlpin.

Psychology

I1 *Society for Research in Child Development*—9:30 a.m.; Symposium on Permissiveness versus Rigidity in Relation to Child Rearing, Personality, and Culture; North Ballroom, New Yorker.

Social and Economic Sciences

K and K1 *Section on Social and Economic Sciences; and Academy of World Economics*—10:00 a.m.; Joint Session; Chelsea Room, Governor Clinton.

K4 *American Sociological Society*—10:00 a.m.; Concurrent Session 1, Progress in Research in Racial and Cultural Relations; Gold Room, Manhattan Center. 10:00 a.m.; Concurrent Session 2, Industrial Sociology; Masonic Room, Manhattan Center. 10:00 a.m.; Concurrent Session 3, Frontiers of Demographic Research; Lounge, Manhattan Center.

K9 *Rural Sociological Society*—10:00 a.m.; Session, Rural Sociological Research in the Changing South; Parlors E-H, New Yorker.

Engineering

M and M2 *Section on Engineering; and New York Section of American Institute of Electrical Engineers*—9:00 a.m.; morning, afternoon, and evening; Visual Displays Illustrating the Principles of Television, joint exhibit; East Room, McAlpin.

Medical Sciences

N1 *Subsection on Medicine, Nm*—9:30 a.m.; Symposium on Adrenal Cortex, Part I; Keystone Room, Statler.

Education

Q1 *AAAS Cooperative Committee on Teaching of Science and Mathematics*—10:00 a.m.; General Session, joint meeting of all science teaching societies affiliated with the AAAS; Grand Ballroom, New Yorker.

Science in General

X6 *Sigma Delta Epsilon*—9:00 a. m.; National Council Meeting; Parlor C, Statler.

Wednesday Noon and Afternoon, December 28

AAAS as a Whole

AAAS George Westinghouse Science Awards, Luncheon—12:30 p.m.; Keystone Room, Statler.

British Association for the Advancement of Science—4:30 p.m.; Exchange Public Lecture on The Growing Importance of Infrared Studies in Physics, Chemistry and Biology, by a representative of the BAAS; Grand Ballroom, Statler.

Mathematics

A1 *American Mathematical Society*—2:00 p.m.; General Session; Room 301, Pupin Laboratories. 3:15 p.m.; Concurrent Session 1; Room 301, Pupin Laboratories. 3:15 p.m.; Concurrent Session 2; Room 329, Pupin Laboratories. 4:30 p.m.; Josiah Willard Gibbs Lecture, McMillan Theatre, Columbia.

Astronomy

D *Section on Astronomy*—1:30 p.m.; Session, Ballroom, McAlpin.

Zoological Sciences

F *Section on Zoological Sciences*—12:00 noon; Annual Business Meeting of Section; Grand Ballroom, Statler.

F1 *American Society of Parasitologists*—1:30 p.m.; Annual Luncheon and Business Meeting; Grand Ballroom, Statler. 2:30 p.m. until 5:00 p.m.; Demonstration Session; Room 903, Schermerhorn Hall, Columbia.

F3 *American Society of Zoologists*—12:00 noon; Annual Business Meeting of the Society (immediately following Business Meeting of Section F); Grand Ballroom, Statler. 2:00 p.m.; Concurrent Session 1, General Physiology; Parlor 1, Statler. 2:00 p.m.; Concurrent Session 2, Embryology; Parlor 2, Statler. 2:00 p.m.; Concurrent Session 3, Cytology; Parlor A, Statler. 2:00 p.m.; Concurrent Session 4, Protozoology and Parasitology; Parlor B, Statler.

Zoological and Botanical Sciences

FG2 *American Society of Human Genetics*—2:00 p.m.; Session; Gramercy Room, Governor Clinton. 4:30 p.m.; Annual Business Meeting; Chelsea Room, Governor Clinton.

FG3 *American Society of Limnology and Oceanography*—2:00 p.m.; Joint Session with the Ecological Society of America; Room 411, Kent Hall, Columbia.

FG6 and FG7 *Biometric Society (Eastern North American Region)*; and *Biometric Section, American Statistical Association*—4:00 p.m.; Symposium on The Use of Rationally Developed Equations in Biology; Joint session; Hotel Biltmore.

FG8 *Ecological Society of America*—2:00 p.m.; Concurrent Session 1, General Ecology; Room 502, Kent Hall, Columbia. 2:00 p.m.; Concurrent Session 2, Plant Ecology and Plant Geography; Room 515, Kent Hall. 2:00 p.m.; Concurrent Session 3, Limnology and Oceanography; Joint Session with American Society of Limnology and Oceanography; Room 411, Kent Hall.

FG9 *Genetics Society of America*—2:00 p.m.; Concurrent Session 1; Governor Room, Governor Clinton. 2:00 p.m.; Concurrent Session 2; Florentine Room, Governor Clinton.

FG10 *National Association of Biology Teachers*—2:00 p.m.; Teaching Aids from Outside the Classroom and Laboratory; Parlors F-G, New Yorker.

FG11 *Society for the Study of Evolution*—2:00 p.m.; Symposium on the Role of the South Atlantic Basin in Biogeography and Evolution, Part II; Main lecture room, Brander Matthews Hall, Columbia.

Botanical Sciences

G1 *American Bryological Society*—Joint Sessions, all day, with Systematic Section of Botanical Society of

America and American Society of Plant Taxonomists; at New York Botanical Garden.

G3 *American Phytopathological Society*—1:30 p.m.; Concurrent Session 1, Stone Fruit and Citrus Virus Diseases; Oak Room, Martinique. 3:00 p.m.; Session 2, Stone Fruit Versus Disease Conference; Oak Room, Martinique. 1:30 p.m.; Concurrent Session 3, Vegetable and Small Fruit Crop Diseases; Gold Room, Martinique. 1:30 p.m.; Concurrent Session 4, Conference of Extension Plant Pathologists; El Patio, McAlpin.

G4 *American Society of Plant Physiologists*—1:30 p.m.; Symposium on Some Growth Phenomena Clarified by Tissue and Organ Culture, joint session with Physiological Section of Botanical Society of America (Session 3); Winter Garden, McAlpin. 4:00 p.m.; Business Meeting; Winter Garden, McAlpin.

G5 *American Society of Plant Taxonomists*—2:00 p.m.; Film; Inspection of Herbarium and Library; Joint Session with Systematic Section, Botanical Society of America (Session 5); at New York Botanical Garden.

G6 *Botanical Society of America*—2:00 p.m.; Concurrent Session 1, General Section; Colonial Room, McAlpin. 2:00 p.m.; Concurrent Session 2, Symposium on Mechanism of Cellulose Degradation by Chemical and Biological Agents; Joint Meeting of Microbiological and Paleobotanical Sections; Crystal Room, McAlpin. 1:30 p.m.; Concurrent Session 3, Symposium on Some Growth Phenomena Clarified by Tissue and Organ Culture; Joint Meeting of Physiological Section and American Society of Plant Physiologists; Winter Garden, McAlpin. 2:00 p.m.; Concurrent Session 4, Botanical Teaching Section; Symposium on Botany as a Recreational Subject; Blue Room, McAlpin. 2:00 p.m.; Concurrent Session 5, Film; Inspection of Herbarium and Library; Joint Meeting of the Systematic Section and the American Society of Plant Taxonomists; at New York Botanical Garden.

G7 *Mycological Society of America*—2:00 p.m.; Session; Green Room; McAlpin.

G8 *Phycological Society of America*—2:00 p.m.; Business Meeting; Room F, McAlpin.

Psychology

I1 *Society for Research in Child Development*—2:30 p.m.; Symposium on the Concept of Maturity from the Anatomical, Physiological, and Psychological Points of View; North Ballroom, New Yorker.

Social and Economic Sciences

K4 *American Sociological Society*—1:15 p.m.; Concurrent Session 1, The American Soldier; Gold Room, Manhattan Center. 1:15 p.m.; Concurrent Session 2, Recent Contributions to Family Theory in Different Fields; Masonic Room, Manhattan Center. 1:15 p.m.; Concurrent Session 3, Current Research; Lounge, Manhattan Center. 3:30 p.m.; Concurrent Session 4, Significant Fields of Rural Research; Gold Room, Manhattan Center. 3:30 p.m.; Concurrent Session 5, Mobility in the American Stratification System; Masonic Room, Manhattan Center. 3:30 p.m.; Concurrent Session 6, Social Research in the Federal Government; Lounge, Manhattan Center.

K8 *Pi Gamma Mu*—12:00 noon; Luncheon for invited guests; Greeley Room, Governor Clinton.

K9 *Rural Sociological Society*—12:00 noon; Rural Sociological Research in the Corn and Wheat Belts; Parlors E–H, New Yorker.

Education

Q2 *National Science Teachers Association*—2:00 p.m.; Third National Conference of Industry-Science Teaching Relations; Grand Ballroom, New Yorker.

Science in General

X1 *American Nature Study Society*—2:30 p.m.; Session, Nature Photography; Panel Room, New Yorker.

X3 *Phi Kappa Phi*—1:30 p.m.; Business Meeting, Chelsea Room, Governor Clinton.

X6 *Sigma Delta Epsilon*—12:30 p.m.; Luncheon, Address, Announcement of Award; Georgian Room, Statler.

Wednesday Evening, December 28

AAAS as a Whole

AAAS Presidential Address—8:00 p.m.; Ten Million Scientists; Grand Ballroom, Statler.

AAAS Reception—9:30 p.m.; Grand Ballroom and adjacent rooms, Statler. (Reception open only to registrants.)

AAAS Section M; New York Section of American Institute of Electrical Engineers—8:00 p.m.; Round Table Discussion on Technology of Television; Crystal Room, McAlpin.

Mathematics

A1 *American Mathematical Society*—6:30 p.m.; Meeting of Council of Society; Room 4, John Jay Hall, Columbia.

Zoological Sciences

F3 *American Society of Zoologists*—6:00 p.m.; Zoologists' Dinner; Gold and Oak Rooms, Martinique.

Zoological and Botanical Sciences

FG12 *American Institute of Biological Sciences*—9:30 p.m.; Conference of Secretaries of Biological Societies; Room F, McAlpin.

Botanical Sciences

G3 *American Phytopathological Society*—8:00 p.m.; Concurrent Session 1, The Teaching of Plant Pathology; Winter Garden, McAlpin. 8:00 p.m.; Concurrent Session 2, Fungicide Colloquium; Ballroom, McAlpin. 8:00 p.m.; Concurrent Session 3, Plant Disease Forecasting; East Room, Martinique.

Social and Economic Sciences

K4 *American Sociological Society*—7:00 p.m.; Joint Dinner with the Conference on Family Welfare; Grand Ballroom, New Yorker.

K9 and K3 *Rural Sociological Society*; and *American Farm Economic Association*—8:00 p.m.; Joint Session, The Future of Rural Life in the United States; North Ballroom, New Yorker.

Engineering

M and M2 *Section on Engineering; New York Sec-*

tion of American Institute of Electrical Engineers—8:00 p.m.; Joint Program, Round Table Discussion on Technology of Television; Crystal Room, McAlpin.

Science in General

X4 *National Association of Science Writers*—7:30 p.m.; Business Meeting; Parlor A, Statler.

Thursday Morning, December 29

AAAS as a Whole

AAAS Section Secretaries' Conference—11:30 a.m.; Conference and Lunch for all section secretaries; Parlor 2, Statler.

AAAS Cooperative Committee—8:00 a.m.; Meeting of the *officers* of all science teaching organizations affiliated with the AAAS to plan the 1950 Coordinated Program; Parlor A, New Yorker. 10:00 a.m.; General Session, meeting with all science teaching organizations; Grand Ballroom, New Yorker.

Forum on Research and National Security, Detlev Bronk, Chairman—10:00 a.m.; Grand Ballroom, Statler.

AAAS Subsection Nm—9:30 a.m.; Symposium on Adrenal Cortex, Part II; Keystone Room, Statler.

Mathematics

A1 *American Mathematical Society*—10:00 a.m.; General Session, Annual Business Meeting; Cole Prize Address; Room 301, Pupin Laboratories.

A4 *National Council of Teachers of Mathematics*—10:15 a.m.; Concurrent Session 1; Room 211, Teachers College, Columbia. 10:15 a.m.; Concurrent Session 2, Room 200, Teachers College. 10:15 a.m.; Concurrent Session 3; Room 300, Teachers College.

Astronomy

D *Section on Astronomy*—9:30 a.m.; Contributed Papers; Greeley Room, Governor Clinton.

Geology and Geography

E and E3 *Section on Geology and Geography; Geological Society of America*—9:00 a.m.; Joint Program; North Ballroom, New Yorker.

Zoological Sciences

F1 *American Society of Parasitologists*—9:00 a.m.; Session; Room 501, Schermerhorn Hall, Columbia.

F3 *American Society of Zoologists*—9:00 a.m.; Concurrent Session 1, Animal Behavior and Sociobiology; Joint Meeting with Ecological Society of America; Georgian Room, Statler. 9:00 a.m.; Concurrent Session 2, General Physiology; Parlor 1, Statler. 9:00 a.m.; Concurrent Session 3, Endocrinology; Parlor A, Statler. 9:00 a.m.; Concurrent Session 4, Cell Physiology; Parlor B, Statler.

F4 *Society of Systematic Zoology*—9:00 a.m.; Annual Breakfast and Business Meeting; Parlor 2, Statler.

Zoological and Botanical Sciences

FG2 *American Society of Human Genetics*—Demonstrations, all day; Parlors F and J, Governor Clinton.

FG3 *American Society of Limnology and Oceanography*—9:30 a.m.; Session; Florentine Room, Governor Clinton.

FG8 *Ecological Society of America*—9:00 a.m.; Session, Animal Behavior and Sociobiology; Joint Meeting with American Society of Zoologists; Georgian Room, Statler.

FG9 *Genetics Society of America*—9:00 a.m.; Invitation Program; 309 Havemeyer Hall, Columbia.

FG10 *National Association of Biology Teachers*—8:00 a.m.; Committee Meeting of the *officers* of all AAAS-affiliated science teaching organizations, to plan the Coordinated Program for 1950; Parlor A, New Yorker.

FG11 *Society for the Study of Evolution*—9:00 a.m.; Session; Room 902, Schermerhorn Hall, Columbia.

Botanical Sciences

G3 *American Phytopathological Society*—9:00 a.m.; Concurrent Session 1, Tobacco and Potato Diseases; Oak Room, Martinique. 9:00 a.m.; Concurrent Session 2, Wheat, Oat, and Corn Diseases; Gold Room, Martinique. 9:00 a.m.; Concurrent Session 3, Symposium on Performance of New Fungicidal Sprays and Dusts in 1949; El Patio, McAlpin. 9:00 a.m.; Concurrent Session 4, Council Meeting; West Room, Martinique. 10:30 a.m.; Session 5; West Room, Martinique.

G4 *American Society of Plant Physiologists*—9:00 a.m.; Concurrent Session 1, joint session with Physiological Section of Botanical Society of America (Session 5); Winter Garden, McAlpin. 9:00 a.m.; Concurrent Session 2, joint session with Physiological Section of Botanical Society (Session 6); Ballroom, McAlpin.

G5 *American Society of Plant Taxonomists*—9:30 a.m.; Session, joint meeting with Systematic Section of Botanical Society of America (Session 7); Crystal Room, McAlpin.

G6 *Botanical Society of America*—9:00 a.m.; Concurrent Session 1, Business Meeting of Society; Colonial Room, McAlpin. 9:30 a.m.; Concurrent Session 2, General Section; Colonial Room, McAlpin. 9:30 a.m.; Concurrent Session 3, joint meeting of Microbiological Section with Mycological Society of America; Green Room, McAlpin. 9:30 a.m.; Concurrent Session 4, Paleobotanical Section; Blue Room, McAlpin. 9:00 a.m.; Concurrent Session 5, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 1); Winter Garden, McAlpin. 9:00 a.m.; Concurrent Session 6, joint meeting of Physiological Section and American Society of Plant Physiologists (Session 2); Ballroom, McAlpin. 9:30 a.m.; Concurrent Session 7, joint meeting of Systematic Section with American Society of Plant Taxonomists; Crystal Room, McAlpin.

G7 *Mycological Society of America*—9:30 a.m.; Session, joint meeting with Microbiological Section of Botanical Society (Session 8); Green Room, McAlpin.

Psychology

I1 *Society for Research in Child Development*—9:30 a.m.; Presidential Address and Business Meeting; Panel Room, New Yorker.

Social and Economic Sciences

K2 *Alpha Kappa Delta*—8:00 a.m.; Annual Meeting and Breakfast; Parlors E-H, New Yorker.

K4 *American Sociological Society*—9:00 a.m.; Concurrent Session 1, Japan's Population Prospects; Gold Room, Manhattan Center. 9:00 a.m.; Concurrent Session 2, Industrial Sociology; Masonic Room, Manhattan Center. 9:00 a.m.; Concurrent Session 3, Family Statistics in the United States; Lounge, Manhattan Center.

K9 *Rural Sociological Society*—8:00 a.m.; Session, Rural Sociological Research on Cultural Changes in the Appalachian Ozark Region; East Room, New Yorker. 10:00 a.m.; Session, Rural Sociological Research in the Urbanized Northeast; Parlors F-G, New Yorker.

K10 *Society for the Psychological Study of Social Issues*—10:00 a.m.; Symposium on Racial and Religious Prejudice; East Room, Martinique.

Engineering

M and M2 *Section on Engineering; New York Section of American Institute of Electrical Engineers*—9:00 a.m.; Morning, afternoon, and evening; Visual Displays Illustrating the Principles of Television, joint exhibit; East Room, McAlpin.

Medical Sciences

N *Subsection on Medicine Nm*—9:30 a.m.; Symposium on Adrenal Cortex, Part II; Keystone Room, Statler.

Education

Q1 and Q2 *AAAS Cooperative Committee on the Teaching of Science and Mathematics;* and *National Science Teachers Association*—8:00 a.m.; Committee Meeting of the *officers* of all science teaching organizations affiliated with the AAAS, to plan the Coordinated Program for 1950; Parlor A, New Yorker. 10:00 a.m.; General Session; Grand Ballroom, New Yorker.

Q3 *The Federation of Science Teachers Associations of New York City*—10:00 a.m.; Fourth Annual Junior Scientists Assembly; Grand Ballroom, New Yorker.

Science in General

X1 *American Nature Study Society*—8:00 a.m.; Committee Meeting of the *officers* of all science teaching organizations affiliated with the AAAS, to plan the Coordinated Program for 1950; Parlor A, New Yorker.

X3 *Phi Kappa Phi*—8:00 a.m.; Breakfast and Business Meeting; Chelsea Room, Governor Clinton.

X6 *Sigma Delta Epsilon*—7:30 a.m.; Convention Breakfast; Parlors F-G, New Yorker.

Thursday Noon and Afternoon, December 29

AAAS as a Whole

AAAS Council Meeting—4:30 p.m.; Parlor 2, Statler.

AAAS Cooperative Committee on the Teaching of Science and Mathematics—1:30 p.m.; Symposium on Science in General Education; Grand Ballroom, Statler. 3:30 p.m.; Panel Discussion on Improvement of Science Instruction on the College Level; Grand Ballroom, Statler.

AAAS Section B—2:00 p.m.; Symposium on Present State of Physics, Part I—Elementary Particles; Georgian Room, Statler.

AAAS Section G—2:00 p.m.; Panel Discussion on Botany in the Service of Man; Winter Garden, McAlpin.

AAAS Subsection Nm—2:00 p.m.; Symposium on Adrenal Cortex, Part III; Keystone Room, Statler.

Mathematics

A1 *American Mathematical Society*—2:00 p.m.; Concurrent Session I; Room 301, Pupin Laboratories. 2:00 p.m.; Concurrent Session 2; Room 329, Pupin Laboratories.

A2 *Institute of Mathematical Statistics*—2:00 p.m.; Session I-13, joint session with American Statistical Association; Green Room, McAlpin. 4:00 p.m.; Session I-12, Review of Stochastic Processes; Joint session with American Statistical Association; Green Aoom, McAlpin.

A4 *National Council of Teachers of Mathematics*—12:30 p.m.; Luncheon; John Jay Dining Hall, Columbia. 2:30 p.m.; Concurrent Session 1; Room 211, Teachers College, Columbia. 2:30 p.m.; Concurrent Session 2; Room 200, Teachers College. 2:30 p.m.; Concurrent Session 3; Room 300, Teachers College. 4:30 p.m.; Reception; Men's Faculty Club, Columbia.

Physics

B *Section on Physics*—2:00 p.m.; Symposium on Present State of Physics, Part I—Elementary Particles; Georgian Room, Statler.

Astronomy

D *Section on Astronomy*—2:00 p.m.; Session; Chelsea Room, Governor Clinton.

Geology and Geography

E and E3 *Section on Geology and Geography; Geological Society of America*—2:00 p.m.; Joint Program; North Ballroom, New Yorker.

Zoological Sciences

F1 *American Society of Parasitologists*—2:00 p.m.; Session; Room 501, Schermerhorn Hall, Columbia.

F3 *American Society of Zoologists*—12:30 p.m.; Luncheon and Business Meeting, Committee for the Study of Animal Societies Under Natural Conditions; Dining room, Statler. 3:30 p.m.; Open House and Tea; Department of Animal Behavior, American Museum of Natural History. 4:30 p.m.; Informal Symposium; Department of Animal Behavior, American Museum of Natural History. 2:00 p.m.; Concurrent Session 1, General Morphology, Ecology, Evolution, and Genetics; Room 902, Schermerhorn Hall, Columbia. 2:00 p.m.; Concurrent Session 2, *Demonstrations*; Rooms 652 and 654, Schermerhorn Hall. 2:00 p.m.; Concurrent Session 3, *Demonstrations by Motion Picture Films*; Room 201, Fayerweather Hall, Columbia.

Zoological and Botanical Sciences

FG3 *American Society of Limnology and Oceanography*—2:00 p.m.; Session; Florentine Room, Governor Clinton.

FG6 and FG7 *Biometric Society; and Biometric Section, American Statistical Association*—2:00 p.m.; Session, Long-time Follow-up in Morbidity Studies; Hotel Biltmore.

FG9 *Genetics Society of America*—2:00 p.m.; Concurrent Session 1, *Demonstration Papers*; Room 903-913, Schermerhorn Hall, Columbia. 2:00 p.m.; Concurrent Session 2; Room 309, Havemeyer Hall, Columbia.

FG13 Proposed *Society of Industrial Microbiologists*—4:00 p.m.; Organization Meeting; Ballroom, McAlpin.

Botanical Sciences

G *Section on Botanical Sciences*—2:00 p.m.; Panel Discussion on Botany in the Service of Man; Joint Session of societies of Sections G and FG; Winter Garden, McAlpin.

G3 *American Phytopathological Society*—1:30 p.m.; Concurrent Session 1, Fruit Crop Diseases; Oak Room, Martinique. 1:30 p.m.; Concurrent Session 2, Forage and Miscellaneous Field Crop Diseases; Gold Room, Martinique. 1:30 p.m.; Concurrent Session 3, Diseases of Ornamentals; El Patio, McAlpin. 1:30 p.m.; Concurrent Session 4, Demonstration of Foreign Plant Quarantine Inspection Methods; West Room, Martinique. 2:30 p.m.; Session 5, Council Meeting; West Room, Martinique.

G9 *Torrey Botanical Club*—12:30 p.m.; Luncheon and Address; Colonial Room, McAlpin.

Social and Economic Sciences

K and K4 *Section on Social and Economic Sciences; and American Sociological Society*—2:00 p.m.; Panel Discussion on The Status and Prospects of the Social Sciences, joint session; Gold Room, Manhattan Center.

K4 *American Sociological Society*—2:00 p.m.; Session 1, see preceding joint session with Section K; Gold Room, Manhattan Center. 1:15 p.m.; Concurrent Session 2, Sociological Theory; Masonic Room, Manhattan Center. 1:15 p.m.; Concurrent Session 3, The Understanding of a Foreign Culture, joint session with the American Political Science Association; Lounge, Manhattan Center. 3:30 p.m.; Concurrent Session 4, Sociology and Psychiatry; Masonic Room, Manhattan Center. 3:30 p.m.; Concurrent Session 5, Current Research; Lounge, Manhattan Center.

K5 *American Statistical Association*—4:00 p.m.; Review of Stochastic Processes, joint session with Institute of Mathematical Statistics; Green Room, McAlpin.

K9 *Rural Sociological Society*—1:00 p.m.; Session, A Critique of Basic Research; Parlors F-G, New Yorker. 3:00 p.m.; Session, Rural Sociological Research in the Pacific Coast States; Parlors F-G, New Yorker.

Medical Sciences

N1 *Subsection on Medicine, Nm*—2:00 p.m.; Symposium on Adrenal Cortex, Part III; Keystone Room, Statler.

Education

Q1 *AAAS Cooperative Committee on the Teaching of Science and Mathematics*—1:30 p.m.; Symposium on Science in General Education; Grand Ballroom, Statler. 3:30 p.m.; Panel Discussion on Improvement of Science Instruction on the College Level; Grand Ballroom, Statler.

Thursday Evening, December 29

AAAS as a Whole

Biologists' Smoker, sponsored by American Society of Naturalists—9:00 p.m. until 12:00 midnight; Roosevelt Hall, American Museum of Natural History. (All welcome, but open only to registrants, or those who pay a registration fee upon arrival.)

AAAS Section M; New York Section of American Institute of Electrical Engineers—8:00 p.m.; Joint Program, Round Table Discussion on the Impact of Television on Society and Future Developments; Crystal Room, McAlpin.

AAAS Subsection Nm—7:30 p.m.; Symposium on Adrenal Cortex, Part IV; Keystone Room, Statler.

AAAS Cooperative Committee on Teaching of Science and Mathematics—6:30 p.m.; Joint Banquet of all science teaching societies affiliated with AAAS; Grand Ballroom, New Yorker.

Mathematics

A1 and A3 *American Mathematical Society; and Mathematical Association of America*—6:30 p.m.; Dinner for the mathematical organizations; John Jay Hall Dining Room, Columbia.

A4 *National Council of Teachers of Mathematics*—6:30 p.m.; Dinner; Men's Faculty Club, Columbia.

Zoological and Botanical Sciences

FG2 *American Society of Human Genetics*—8:00 p.m.; Address of the Retiring President of Society; Governor Room, Governor Clinton.

FG4 *American Society of Naturalists*—9:00 p.m. till 12:00 midnight; Biologists' Smoker; Roosevelt Hall, American Museum of Natural History. All biologists welcome, but open only to registrants or those who pay a registration fee upon arrival.

Botanical Sciences

G3 *American Phytopathological Society*—6:30 p.m.; Annual Dinner of Society; Ballroom, McAlpin.

G6 *Botanical Society of America*—6:30 p.m.; Dinner for all botanists, Cranbrook Award, Presidential Address; Winter Garden, McAlpin.

Social and Economic Sciences

K4 *American Sociological Society*—8:00 p.m.; General Session of the Society; Grand Ballroom, Statler.

History and Philosophy of Science

L, L1, and L2 *Section on History and Philosophy of Science; American Philosophical Association; Philosophy of Science Association*—8:00 p.m.; Joint Session; Panel Room, New Yorker.

Engineering

M and M2 *Section on Engineering; New York Section of American Institute of Electrical Engineers*—8:00 p.m.; Joint Program, Round Table Discussion on the Impact of Television on Society and Future Developments; Crystal Room, McAlpin.

Medical Sciences

N1 *Subsection on Medicine*—7:30 p.m.; Symposium on Adrenal Cortex, Part IV; Keystone Room, Statler.

Education

Q1 *AAAS Cooperative Committee on Teaching of*

Science and Mathematics—6:30 p.m.; Joint Banquet of all science teaching societies affiliated with AAAS; Grand Ballroom, New Yorker.

Science in General

X2 *Federation of American Scientists*—8:00 p.m.; General Meeting; Georgian Room, Statler.

Friday Morning, December 30

AAAS as a Whole

Academy Conference—10:00 a.m.; Session; Parlor A, New Yorker.

AAAS Section B—9:30 a.m.; Symposium on the Present State of Physics, Part II—Physics of the Solid State; Georgian Room, Statler.

Mathematics

A2 *Institute of Mathematical Statistics*—9:00 a.m.; Session I-15, Symposium on Statistical Methods in Astronomy; Joint Program with American Statistical Association and AAAS Section D; Governor Room, Governor Clinton.

A3 *Mathematical Association of America*—9:30 a.m.; Session and Business Meeting; Room 301, Pupin Laboratories, Columbia.

Physics

B *Section on Physics*—9:30 a.m.; Symposium on the Present State of Physics, Part II—Physics of the Solid State; Georgian Room, Statler.

Chemistry

C *Section on Chemistry*—8:45 a.m.; Session; Keystone Room, Statler.

Astronomy

D *Section on Astronomy*—9:00 a.m.; Symposium on Statistical Methods in Astronomy, joint session with Institute of Mathematical Statistics and American Statistical Association; Governor Room, Governor Clinton.

Geology and Geography

E and E3 *Section on Geology and Geography; Geological Society of America*—9:00 a.m.; Joint program; North Ballroom, New Yorker.

Zoological Sciences

F3 *American Society of Zoologists*—9:00 a.m.; Concurrent Session 1, General Physiology; Parlor 1, Statler. 9:00 a.m.; Concurrent Session 2, Endocrinology; Parlor 2, Statler. 9:00 a.m.; Concurrent Session 3, Embryology; Parlor A, Statler. 9:00 a.m.; Concurrent Session 4, Cellular and General Physiology; Parlor B, Statler.

Zoological and Botanical Sciences

FG3 *American Society of Limnology and Oceanography*—9:30 a.m.; Session; Florentine Room, Governor Clinton.

FG4, FG8, FG9, F3, G4, and G6 *American Society of Naturalists; Ecological Society of America; Genetics Society of America; American Society of Zoologists; American Society of Plant Physiologists; and Botanical Society of America*—9:00 a.m.; Symposium on Reproduction in Plants; Joint Meeting; Grand Ballroom, Statler.

FG6 and FG7 *Biometric Society; Biometric Section, American Statistical Association*—10:00 a.m.; Session, joint meeting; Hotel Biltmore.

Botanical Sciences

G3 *American Phytopathological Society*—9:00 a.m.; Business Meeting; Oak Room, Martinique. 10:30 a.m.; Concurrent Session 2, Diseases of Forest and Shade Trees; Oak Room, Martinique. 11:00 a.m.; Concurrent Session 3, Flax, Safflower, Rice, and Sugar Cane Diseases; Gold Room, Martinique.

G6 *Botanical Society of America*—9:30 a.m.; Concurrent Session 1, General Section; Colonial Room, McAlpin. 9:30 a.m.; Concurrent Session 2, joint meeting of Microbiological Section with Mycological Society of America; Green Room, McAlpin. 9:30 a.m.; Concurrent Session 3, Botanical Teaching Section; Blue Room, McAlpin.

G7 *Mycological Society of America*—9:30 a.m.; Session, joint meeting with Microbiological Section of Botanical Society of America (Session 2); Green Room, McAlpin.

Social and Economic Sciences

K4 *American Sociological Society*—9:00 a.m.; Concurrent Session 1, Methods of Empirical Research in Sociology; Gold Room, Manhattan Center. 9:00 a.m.; Concurrent Session 2, Social Mobility and Social Stratification in European Societies; Masonic Room, Manhattan Center. 9:00 a.m.; Concurrent Session 3, Social Structure of the Public Schools; Joint Meeting with American Political Science Association; Lounge, Manhattan Center.

K5 *American Statistical Association*—9:00 a.m.; Symposium on Statistical Methods in Astronomy; Joint Program with Institute of Mathematical Statistics and AAAS Section D; Governor Room, Governor Clinton.

K9 *Rural Sociological Society*—8:00 a.m.; Session, Rural Sociological Research in the Semi-Arid West; Parlors F and G, New Yorker.

History and Philosophy of Science

L, L1, and L2 *Section on History and Philosophy of Science; American Philosophical Association; and Philosophy of Science Association*—9:30 a.m.; Joint Session; Panel Room, New Yorker.

Engineering

M and M2 *Section on Engineering; New York Section of American Institute of Electrical Engineers*—9:00 a.m.; morning, afternoon, and evening; Visual Displays Illustrating the Principles of Television, joint exhibit; East Room, McAlpin.

Medical Sciences

N2 *Subsection on Dentistry*—9:30 a.m.; Session; El Patio, McAlpin.

Education

Q3 *The Federation of Science Teachers Associations of New York City*—Field Trips (arranged in advance).

Science in General

X1 *American Nature Study Society*—8:30 a.m.; All Day Field Trip; Starting from Parlor B, New Yorker.

X8 *The Academy Conference*—10:00 a.m.; Session; Parlor A, New Yorker.

Friday Noon and Afternoon, December 30

AAAS as a Whole

Academy Conference—2:30 p.m.; Session; Parlor A, New Yorker.

AAAS Section B—1:30 p.m.; Symposium on the Present State of Physics, Part III—Chemical Physics; Georgian Room, Statler. 3:30 p.m.; Symposium on the Present State of Physics, Part IV—Biophysics; Georgian Room, Statler.

AAAS Section F—2:00 p.m.; Symposium on Steroid Hormones and Sex Differentiation in Vertebrates; Grand Ballroom, Statler.

Mathematics

A3 *Mathematical Association of America*—2:30 p.m.; Session; Room 301, Pupin Laboratories, Columbia.

Physics

B *Section on Physics*—1:30 p.m.; Symposium on the Present State of Physics, Part III—Chemical Physics; Georgian Room, Statler. 3:30 p.m.; Symposium on the Present State of Physics, Part IV—Biophysics; Georgian Room, Statler.

Chemistry

C *Section on Chemistry*—2:00 p.m.; Session; Keystone Room, Statler.

Geology and Geography

E, E1, and E2 *Section on Geology and Geography; American Geographical Society of New York;* and *Association of American Geographers*—2:00 p.m.; Joint session; North Ballroom, New Yorker.

Zoological Sciences

F *Section on Zoological Sciences*—2:00 p.m.; Symposium on Steroid Hormones and Sex Differentiation in Vertebrates; Grand Ballroom, Statler.

Zoological and Botanical Sciences

FG1 *American Microscopical Society*—4:00 p.m.; Annual Business Meeting; Parlor 2, Statler.

FG11 *Society for the Study of Evolution*—1:00 p.m.; Business Meeting of Society; Room 902, Schermerhorn Hall, Columbia. 2:00 p.m.; Session; Room 902, Schermerhorn Hall.

Botanical Sciences

Trip to Boyce Thompson Institute for Plant Research—1:30 p.m.; Buses leave Hotel McAlpin; return 5:30 p.m.

G2 *American Fern Society*—2:00 p.m.; Session; Blue Room, McAlpin.

G3 *American Phytopathological Society*—1:30 p.m.; Concurrent Session 1, joint meeting with Mycological Society of America; Crystal Room, McAlpin. 1:30 p.m.; Concurrent Session 2, Fungicides and Methods of Application; Oak Room, Martinique. 1:30 p.m.; Concurrent Session 3, Virology; Gold Room, Martinique. 1:30 p.m.; Session 4, Council Meeting; West Room, Martinique.

G6 *Botanical Society of America*—2:00 p.m.; Concurrent Session 1, General Section; Colonial Room, McAlpin. 2:00 p.m.; Concurrent Session 2, joint meeting of Microbiological Section with Mycological Society of America; Green Room, McAlpin.

G7 *Mycological Society of America*—1:30 p.m.; Concurrent Session 1, joint meeting with the American Phytopathological Society; Crystal Room, McAlpin. 2:00 p.m.; Concurrent Session 2, joint meeting with Microbiological Section of Botanical Society of America (Session 2); Green Room, McAlpin.

Social and Economic Sciences

K *Section on Social and Economic Sciences*—2:30 p.m.; Joint Session with Econometric Society; Topic: Economics and Technology; Production Functions; Governor Room, Governor Clinton.

K4 *American Sociological Society*—1:15 p.m.; Concurrent Session 1, Opportunities for Social Research in the 1950 Censuses; Gold Room, Manhattan Center. 1:15 p.m.; Concurrent Session 2, Experimental Study of Small Groups; Masonic Room, Manhattan Center. 1:15 p.m.; Concurrent Session 3, Human Ecology; Lounge, Manhattan Center.

K6 *Econometric Society*—2:30 p.m.; Joint Session with Section K; Topic: Economics and Technology: Production Functions; Governor Room, Governor Clinton.

K7 *Metric Association*—2:30 p.m.; Annual Meeting; Society's Suite, Governor Clinton.

History and Philosophy of Science

L, L1, and L2 *Section on History and Philosophy of Science; American Philosophical Association;* and *Philosophy of Science Association*—2:00 p.m.; Joint Program; Panel Room, New Yorker.

Medical Sciences

N2 *Subsection on Dentistry*—2:00 p.m.; Session; El Patio, McAlpin.

Agriculture

O *Section on Agriculture*—2:00 p.m.; Symposium on Whither Soil Conservation?; Ballroom, McAlpin.

Education

Q3 *The Federation of Science Teachers Associations of New York City*—Series of Field Trips; for details, see Booth of Federation, New Yorker.

Science in General

X8 *The Academy Conference*—2:30 p.m.; Session; Parlor A, New Yorker.

Friday Evening, December 30

AAAS as a Whole

Academy Conference—6:00 p.m.; Academy Conference Dinner; Place to be announced.

AAAS Section F—8:00 p.m.; Symposium on The

Kinsey Report and Its Contributions to Related Fields; Grand Ballroom, Statler.

Chemistry

C *Section on Chemistry*—7:15 p.m.; Session; Keystone Room, Statler.

Zoological Sciences

F *Section on Zoology*—8:00 p.m.; Symposium on The Kinsey Report and Its Contributions to Related Fields; Grand Ballroom, Statler.

Zoological and Botanical Sciences

FG4 *American Society of Naturalists*—8:00 p.m.; Annual Meeting, Presidential Address; Parlor 1, Statler.

Social and Economic Sciences

K7 *Metric Association*—6:30 p.m.; Board Meeting and Dinner; Society's Suite, Governor Clinton.

History and Philosophy of Science

L, L1, and L2 *Section on History and Philosophy of Science; American Philosophical Association;* and *Philosophy of Science Association*—8:00 p.m.; Joint Program; Panel Room, New Yorker.

Medical Sciences

N2 *Subsection on Dentistry*—7:30 p.m.; Dinner and Informal Round Table Discussion; Blue Room, McAlpin.

Science in General

X8 *The Academy Conference*—6:00 p.m.; Academy Conference Dinner; Place to be announced.

Saturday Morning, December 31

Chemistry

C *Section on Chemistry*—8:30 a.m.; Session; Keystone Room, Statler.

Saturday Noon and Afternoon, December 31

Chemistry

C *Section on Chemistry*—1:30 p.m.; Session; Keystone Room, Statler.

Annual Science Exposition

The AAAS Annual Science Exposition is located in the Penn Top and adjacent Salle Moderne, large rooms on the 18th floor of the Hotel Statler. From the hotel lobby, the Exposition is readily reached by express elevators which are marked 10–18.

Admission to the Annual Science Exposition is open to all adults attending the Meeting. During periods of congestion, if necessary, admission will be restricted to registrants and invited guests with admission coupons. Limitations of space make impossible the admission of children. The evening of Wednesday, December 28, has been set aside, primarily, for New York high school seniors who are serious science majors and have tickets.

Hours of the Annual Science Exposition

Monday, December 26	2:00 p.m. to 6:00 p.m.
Tuesday, December 27	9:00 a.m. to 9:00 p.m.
Wednesday, December 28	9:00 a.m. to 9:00 p.m.
Thursday, December 29	9:00 a.m. to 6:00 p.m.
Friday, December 30	9:00 a.m. to 6:00 p.m.
Saturday, December 31	9:00 a.m. to 12 noon

Special Exhibits

Technically not a part of the Annual Science Exposition, but associated with it, are:

1. THE ANNUAL INTERNATIONAL PHOTOGRAPHY-IN-SCIENCE SALON, sponsored by *The Scientific Monthly* and the Smithsonian Institution. This is located on the walls of the part of the Salle Moderne that houses the Visible Directory of Registrants. This outstanding exhibition of 175 color and black-and-white prints is described under AAAS Prize Awards.

2. THE FIFTH OPEN EXHIBIT OF TECHNICAL PHOTOGRAPHY, sponsored by the Photographic Society of America. This is located on one wall of the short corridor connecting the Penn Top and the Salle Moderne. Some 25 accepted prints, which represent only the Technical Division of this large 1949 P.S.A. Exhibition of Photography, are on display. Previously, these were shown at the City Art Museum, St. Louis, October 17–November 1.

3. THE EXHIBIT OF THE U. S. NATIONAL BUREAU OF STANDARDS. This occupies the other wall of the corridor connecting the Penn Top and the Salle Moderne, and consists of three parts, entitled:

Unification of Screw Threads—An accord was reached between the United States, Great Britain, and Canada to promote commerce between these nations by the standardization of threaded parts for greater interchangeability of products; *Electron-Optical Shadow Method*—A technique developed at the N.B.S. provides a valuable new tool for the quantitative study of electrostatic and magnetic fields of extremely small dimensions; *An Atomic Standard of Frequency and Time*—A new, primary standard of frequency and time developed at the National Bureau of Standards is based on the constant natural frequency associated with the vibration of the atoms in the ammonia molecule.

Exhibits in the Annual Science Exposition

An exhibition of the latest and best in scientific books, instruments, and materials, by firms that produce or distribute such essential aids to science, has been a feature of the meetings of the Association for many years. Perhaps the first *organized* exhibition of the AAAS should be established as the one held in conjunction with the 79th

Meeting in Washington, D. C., 1924. There were, however, exhibits in preceding years. Represented were such pioneers as the American Optical Company, Bausch and Lomb Optical Company, Central Scientific Company, Eastman Kodak Company, General Biological Supply House, Inc., E. Leitz, Inc., and Ward's Natural Science Establishment, Inc.—all of whom, incidentally, are in the 1949 Annual Science Exposition. The continued participation of these concerns, and of many others who have come to exhibit regularly, clearly indicates that the Exposition is of mutual advantage to the scientists in attendance and to the exhibitors.

This year some 70 exhibitors, including a gratifying number of companies new to this Exposition, are occupants of the 86 booths. They fill all the available space (there were late-comers that, unfortunately, could not be accommodated). All exhibitors have invested funds, time, and effort to set up their exhibits and to man their booths during the convention week. They are glad to have an *exceptional opportunity to meet customers in person*, to benefit from the experience of those who consume their products, and to learn of new needs which they may be able to fill. Those who provide the tools of science also advance science. As crowded as the week is, nearly everyone will find time to see the Annual Science Exposition of 1949.

This year the Exposition is unusually compact and convenient—but, necessarily, the aisles are narrower than ideal. For this reason, all are asked to *enter the Penn Top*—which has two long aisles, thus four rows of booths—and to *leave through the Salle Moderne*, which houses 19 booths, the Visible Directory, and the Photography-in-Science Salon.

The exhibitors and short descriptions of their exhibits follow in alphabetical order:

AAAS. New Member Service—*Science*—*The Scientific Monthly*. **(Booth located in main corridor, across from main Registration.)** There are personal advantages in joining the Association. Every person in attendance at the 116th Meeting who is not a member of the AAAS is cordially invited to visit the New Member Service for information concerning the Association. Since its founding, in 1848, the Association has admitted to membership not only professional scientists but also other men and women who have a general interest in science, who wish to keep informed of the progress of science, and who would like to support the high purposes of the one organization that represents all science.

Included in the annual dues of $6.50 (for 1950), each member has a choice of a year of *Science*, the professional scientist's newsweekly, or *The Scientific Monthly* (or *both*, for an additional $3.50). Free sample copies of these two publications will be distributed. Members of the AAAS are requested to nominate fellow scientists for membership, and all not familiar with both magazines are invited to visit this booth. *Prospective advertisers* may obtain sample copies of the magazines and rate cards.

Academic Press, Inc. (Booth 1A). It is the aim of Academic Press to aid research workers in the various fields of science in keeping abreast of all recent developments. Visitors stopping at the Academic Press display will find an array of books intended to fulfill this purpose. They will note the "Advances" series which have become well established and are published yearly. Chemists, biochemists, and biologists alike will be able to peruse reviews in their special spheres of interest, while physicists and mathematicians may browse through publications of such Nobel Prize winners as Sommerfeld and von Laue. Those active in industry and the teaching profession alike will not want to miss Feigl's new book, *Chemistry of specific, selective and sensitive reactions*, or Foster's *Chemical activities of fungi*, and a great many others. A stop at the Academic Press exhibit will also acquaint members and friends of the AAAS with future publications scheduled for the coming year.

Aero Service Corporation (Booth 76). Relief maps—formed in lightweight, durable plastic—are the new teaching aids exhibited by Aero Service Corporation. A portfolio of 12 U. S. Geological Survey quadrangles, representing typical physiography in the United States, will be shown. Selected by leading educators, these quadrangle portfolios are now in use in nearly 300 college geology and geography classes. Each quad, 17 by 22 inches in size, weighs only 4 ounces. Additionally, a handsome 9-color relief map of Venezuela will be exhibited. Its scale is 1: 1,250,000; its size, 45 by 56 inches; its weight, only 2 pounds. These maps have been distributed to many Venezuelan schools and government agencies by Creole Petroleum Corporation. In production is a new plastic relief map of the United States in 11 colors. Its size will be 64 by 40 inches: its weight, less than three pounds. It will give the American student of any age a vivid, accurate understanding of his country's physiography.

Albino Farms (Booth 19). The Albino Farms, P. O. Box 331, Red Bank, New Jersey, will exhibit their laboratory animals which are bred on their farms. The animals will consist of Swiss White Mice, White Rats, C 57 Mice and Hamsters. Cages will be used to house the animals and are expected to be placed in a position so that the convenience of the members will be assured. A representative will be on hand at all times to answer inquiries relative to the animals being displayed. Those members wishing to discuss the problems pertaining to the animals may ask to see Mr. M. L. Wachtel, who is qualified in this regard. All members are invited to visit our exhibit, and it is the desire of the Albino Farms to see to it that you become acquainted with us and our purpose to serve science in all its relationships with our animals for comparable and exact results by meeting exact specifications desired by the scientific fields.

American Book Company (Booth 14). American Book Company, publishers of school and college textbooks, has on display a representative selection of its newer and active publications in the field of science. Featured at the exhibit is advance proof of the eighth edition of Gray's *Manual of botany* which has been in preparation for over 20 years and the publication of which is eagerly awaited by the profession. Included in the exhibit is a copy of the first edition—a rare collector's item—as well as copies of the succeeding editions published over the interval of a hundred years. Containing some 1,600 pages with over 1,800 illustrations, almost wholly rewritten, chiefly by Professor Merritt Lyndon Fernald, with three genera revised by their greatest living masters, the book contains about 8,000 species and varieties. The publication of this book is an event of major importance in the history of education and in educational publishing.

American Cancer Society, Inc. (Booths 59 and 60). *American Cancer Society—Organization and Program*: Under a diagram showing the organization of the American Cancer Society, the various aspects of its program, including education, service, research, and Field Army activities are portrayed by means of three-dimensional figures and illuminated drawings. Side panels show cancer centers by state in relation to population and the distribution of funds. Charles S. Cameron, M.D., Medical and Scientific Director.

American Instrument Company, Inc. (Booth 81). The American Instrument Company will exhibit: *Electrophoresis Apparatus*. . . . The most advanced and complete electrophoresis laboratory housed in a compact and portable unit for research and routine work; *Rotary Warburg Apparatus*. . . . New and improved design for microrespiration studies; *Coleman Spectrophotometer*. . . . Truly universal, 5 instruments in one—spectrophotometer, photofluorometer, nephelometer, titrator, and sensitive galvanometer; *MacBeth pH Meter*. . . . A new dual titration meter and pH meter of utmost sensitivity and flexibility; *Automatic Pipetting Machine*. . . . For delivering accurately measured quantities of liquids (0.05 to 60-ml volumes) into ampoules, vials, etc.; *Constant Temperature Bath*. . . . For close, dependable temperature control; *Waring Blendor*. . . . The speediest and most efficient device for the preparation of extractions, suspensions, and emulsions; *Micro Kjeldahl Apparatus*. . . . Electrically heated, for micro and semimicro digestions and Soxhlet extractions.

American Optical Company (Booths 53 and 54). The Instrument Division of the American Optical Company will display several new instruments. The new laboratory microscopes, either with or without attached substage illuminators, are more rigid and one-third lighter than previous models, and much improved in design. The MC Delineascope is a three-purpose projector for 2 in. x 2 in. slides and single or double frame slidefilm. The Scholar's Microscope, with a built-in light source, is smaller and more convenient than most school models, and is practically foolproof, even for the beginning microscopist. A simplified stereoscopic microscope with a double nosepiece and platen stage is less expensive but of the same optical quality as other Spencer microscopes. The electronic drive Microfilm Reader enlarges 16-mm microfilm conveniently. The Phase Microscope, the 735 Microscope Lamp, the Hb-Meter, polarizing and metallurgical microscopes, microtomes, colorimeter, refractometer, and the GK Auditorium Delineascope also will be shown. Representatives W. F. Butler, W. E. Folland, G. W. Frid, and O. E. Schaefer will be in attendance to discuss any optical questions presented.

American Tobacco Company, Inc. (Booths 31 and 32). The exhibit of the American Tobacco Company's Research Laboratory, Richmond, Virginia, will stress the role of technology in the selection and processing of tobacco, as well as the manufacture of tobacco products. Samples of the more important tobacco types and a variety of compounds which have been identified in tobacco will be displayed. Each sample will be suitably labeled and described. In addition, a short sound movie will cover some of the activities within the laboratory and will include references to the progress of research in the tobacco industry. Mr. O. L. Hillsman and Mr. J. M. Moseley will be in attendance.

Appleton-Century-Crofts, Inc. (Booth 50). Appleton-Century-Crofts, Inc., enters, in 1950, its 125th year of book publishing. The present firm was established in 1948 as the result of the merger of D. Appleton-Century Company, Inc., established in 1933, and F. S. Crofts & Co., founded in 1924. D. Appleton-Century Company, Inc., was itself the result of the merger of The Century Co., founded in 1870, and D. Appleton and Company, founded in 1825. These famous publishing houses have been distinguished for their contributions to education, particularly in the areas of the sciences. Among the books exhibited at the Appleton-Century-Crofts booth in the Annual Science Exposition are outstanding college textbooks, by noted authorities, in the fields of anthropology, astronomy, biology, botany, chemistry, education, general science, geology, mathematics, medicine, and psychology. Many of these books have become standard texts in their fields. All of them are in use in universities and colleges throughout the country.

Bausch and Lomb Optical Company (Booths 47, 48, and 49). At the Bausch and Lomb booths, visitors will have an opportunity to examine and use many of the latest B & L developments in the scientific instrument line. These instruments will include the new Research Microscope, Model E, with low position, fine adjustment, and latest developments in Phase Contrast Microscope Accessories and Microscope Illuminators. The recently introduced Student Microscope, Wide Field Stereoscopic and Polarizing Microscopes with five-axis Universal stage will be shown. Visitors who bring their own microscope slides will have an opportunity of examining them with these new instruments. Photomicrographers will be able to see and operate the new photomicrographic equipment, Model L, which is adaptable over a wide range of magnification and specimen selections. The new "Abbe-56" Refractometer will be a featured instrument in the display of refractometers and spectroscopes which are useful teaching aids in physics and chemistry, as well as for research and laboratory work.

Biological Abstracts (Booth 78). A cooperative, nonprofit journal published by biologists for biologists, *Biological Abstracts* is the only abstracting and indexing service in the world that affords an adequate coverage of the literature in all fields of biology. Currently abstracting upward of 3,000 journals, the coverage is being expanded as rapidly as possible to include many more European, Scandinavian, and Asiatic journals that are not available to the scientists of this country.

As well as the complete edition, *Biological Abstracts* also is published in nine low-priced sectional editions that were specially designed for individual biologists who are interested only in one or more closely related fields. These sectional editions, and the complete edition, will be on display—and the Editor-in-Chief and Business Manager will be in attendance to welcome visitors and furnish information. Stop in at Booth No. 78 and see how one scientific journal has solved the high cost of printing.

Bioscope Manufacturing Company (Booth 34). The Bioscope is an instrument designed primarily for classroom projection of microscopic material. It may either take the place of microscopes or simplify and speed up the use of microscopes. This instrument projects microscopic material downward on a table or on a wall screen where a large group may study the subject and have particular parts actually pointed out to them. Many teachers say the Bioscope, which costs less than one microscope, has the teaching value of a dozen microscopes. Standard equipment includes one 16× projection lens, one 8× wide field projection lens, lifetime transformer and polarizing attachment. Height 24 inches, weight 12 pounds.

Blakiston Company (Booth 4). Come by the Blakiston Company's booth to see Schmalhausen's *Factors of evolution* and Gates's *Pedigrees of Negro families*, both new contributions to their fields; Lee's *Vade Mecum*, internationally known as the outstanding work on histologic technic; Suckling's *Examination of water supplies*; Newton's *Recent advances in physiology*; Emerson and Shields' *Laboratory and field exercises in botany*, which can be used with any standard text, but which with Emerson's *Basic botany* gives a unique coverage of the field for freshman students; and don't miss seeing Blakiston's *New Gould medical dictionary*—the first completely new unabridged medical dictionary in 38 years—contains hundreds of new words, including terms used in biology, botany, pharmacy, medical physics, and chemistry. An anatomical atlas with 252 illustrations, 129 in color, makes this the most complete, most useful research tool available.

Bussey Products Company (Booth 21). Bussey Products Company presents its complete line of laboratory cages for small animals as well as feeding and watering devices. Sample cages for mice, rats, hamsters, guinea pigs, rabbits, and monkeys are displayed. Bussey's popular ''Permaweld'' process is featured in these cages. All laboratory equipment shown is available for immediate shipment.

Cambridge Instrument Company, Inc. (Booth 58). Of interest to scientists in many fields, important developments in Cambridge instruments are presented. For use in measuring radioactive emission, Cambridge shows its Precision Ionization Meter (Failla Design), ''Chang & Eng'' Fast Neutron Detector, Lindemann-Ryerson Electrometer which incorporates improvements developed by the Ryerson Laboratory during the recent war, and the Cambridge Pocket Gamma-Ray Dosimeter with Charging Unit. For use in medicine, Cambridge exhibits two portable Electrocardiographs, its ''Simpli-Trol'' model Standard String Galvanometer instrument and its ''Simpli-Scribe'' Direct Writer. The Cambridge exhibit also includes: the multipurpose combination model Cambridge Surface Pyrometer with three interchangeable thermocouples. Cambridge Research pH Meter which uses an electron-ray null-point indicator in making precision determinations; sensitivity .005 pH, reproducibility .01 pH. The sturdy and inexpensive Cambridge Pot Galvanometer, a combined pointer and reflecting galvanometer for general and student use.

Canadian Radium and Uranium Corporation (Booth 75). The Seederer-Kohlbusch Microbalance is being exhibited. Resembling the conventional analytical balance in appearance, the instrument contains a small radioactive source, mounted upon the beam. Any movement of this latter registers as an unbalance in the two halves of a split ionization chamber, connected in opposition. The final significant figures are read directly upon the output meter of a vacuum tube electrometer. A sensitivity of 10^{-8} gm is attained, with a reproducibility on the order of one microgram.

Another new development to be demonstrated is the ''Telicon''; an instrument by means of which radiation fields may be viewed in relation to their sources and other nearby objects. Phenomena such as the rarefaction and compression zones of sound waves, and the scatter and absorption of radium gamma radiation are clearly visible. The exhibit includes a number of photographs of various radiation field phenomena, photographed by means of this instrument.

Carolina Biological Supply Company (Booth 33). The Carolina Biological Supply Company of Elon College, North Carolina, and Waubun Laboratories of Schriever, Louisiana, will be represented at the Annual Science Exposition by an attractive and interesting exhibit. The exhibit will include biological materials from the culture, slide, preserved materials, and other departments, to illustrate the most up-to-date methods of cultivation of microorganisms, the preparation of microscope slides, and the preservation and injection of macroscopic specimens. Several processes will be completely demonstrated, thus serving to illustrate routine practices in our laboratories. A staff of professional biologists will be in charge of the exhibit and will offer a complete biological materials information service. Literature, including teaching aids, will be available free of charge to those viewing the exhibit. We extend a cordial invitation to you to visit with us in our booth.

Fred S. Carver Inc. (Booth 27). We will exhibit the new model of our standard ten-ton Carver Laboratory Press. The new model incorporates certain refinements, modifications and changes, but is basically the same standard equipment which has been accepted as standard laboratory apparatus by government laboratories, colleges, universities, and research institutions all over the world. The press will be shown with its standard accessories for numerous pressing tests in the biological, chemical, physical, and mechanical fields. One of the unique features of this equipment is the Carver standard accessories available for optional use. These provide means for handling numerous materials for some 60 general applications of small-scale pressing tests. We will also have on display a museum collection showing samples of work done by users with the Carver Laboratory Press. Samples will include plastic molded items; laminations; pressed oils and liquids; extracts; briquetted items, metallographic mountings; crushing, breaking, and shear test specimens; etc.

Central Scientific Company (Booths 28 and 29). The Central Scientific Company exhibit will feature a new line of Cenco D.C. measuring instruments including Wheatstone Bridges, Potentiometers, Volt Boxes and Resistance Boxes; a new Pressovac Pump for vacuum only, guaranteed to produce 25 microns; the new Cenco Titration-pH Stand and Apparatus; the Cenco Electronic Electrometer; new All-Metal Slide Rule; the Cenco Anthropometer; a new laboratory model Radiation Meter; Synchronous Motor Drive Laboratory Timer; new Adjustable Laboratory Tripod; Fluorescent Mineral Kit with Ultraviolet Lamp and many other new instruments of interest to scientists.

Cinchona Products Institute, Inc. (Booth 7). A display showing colored illustrations of malaria plasmodia, pictures of the cinchona plantations in Java, the major research projects carried on in universities and medical schools here and in Holland. Literature on the use of cinchona alkaloids as well as the book *Cinchona in Java* will be available for free distribution.

Coreco Research Corporation (Booth 5). Featured will be the Coreco Automatic Color Camera, Model #300. The "Coreco" Camera is designed to photograph all surface areas of the body—from 1-to-1 close-up pictures to half-body size—and all cavities of the human body, such as mouth, throat, ear, nose, vagina, and rectum. The camera carries its own specially developed, fully color-corrected bulb and a mechanism for complete control of its color, temperature, and exposure within the camera itself. There is an automatic view finder synchronized with the automatic camera mechanism to permit viewing until a fraction of a second before exposure. The camera provides for automatic focusing. An x-ray film applicator is included, making it possible to record all sizes and densities of x-ray film on Kodachrome transparencies.

Thomas Y. Crowell Company (Booth 16). The Thomas Y. Crowell Company, publishers of books, will present a display of its college texts and reference books at the Annual Science Exposition, December 26–31, New York City. These are largely in the fields of chemistry, geography, anthropology, biology, and the social sciences. Featured in the Crowell Booth will be a new introductory biology text by William Etkin, the newly revised *Introductory college chemistry* (2d edition) by Joseph A. Babor and Alexander Lehrman—both books scheduled for publication early in 1950—and the recently revised *Experimental general chemistry* (2d edition) by J. W. Neckers, T. W. Abbott, and K. A. Van Lente. Copies of these new books will be available for inspection. Over thirty other books will be on display. Among them will be such recently published texts as *World political geography* by G. Etzel Pearcy, Russell H. Fifield and Associates, *Man in environment: An introduction to sociology* by Paul H. Landis, and *General anthropology* by Harry Holbert Turney-High. The list will include, as well, Spanish translations of several Crowell texts in the science field.

Denoyer-Geppert Company (Booth 24). Denoyer-Geppert Company will have on display eight of the new Kampmeier Anatomy Charts, a rather wide selection of models for anatomy and biology, some demonstration and museum preparations, and a selection of imported wall charts for zoology and comparative anatomy. We wish to call special attention to the Kampmeier Anatomy Charts, which include systems heretofore not presented in large size chart form such as the lymphatic system, urogenital system, and the topography of organs in male and female. A portion of our exhibit will be devoted to the display of Kodachrome slides covering many fields of the biological sciences. We shall be pleased to have the opportunity of consulting with you in the selection of sustained-use visual teaching aids best suited to your particular requirements and look forward to your visit to our exhibit.

Eastman Kodak Company (Booths 17 and 18). On exhibit by the Eastman Kodak Company are photomicrographs illustrating the use of photography in autoradiography, nuclear physics, and other fields of science. Projection apparatus is available for examining autoradiographs and nuclear events in photographic plates.

Encyclopaedia Britannica (Booth 71). On display will be the latest printing of the oldest, most honored, and most widely read encyclopaedia in the English language. *Encyclopaedia Britannica* is the product of more than 4,000 eminent contributors representing the world's great authorities in every field of knowledge from sixty-two different countries. Exhibitors will explain *Encyclopaedia Britannica's* continuous revision policy, and how the Britannica owner of today is kept up to date with the *Britannica book of the year*, a one-volume, annual encyclopaedia of approximately a million words and written by many of the same, world-famous contributors. This basic reference work of technical and professional men and women for more than 180 years is now indexed with half a million references and cross references, and is a part of Britannica's Ten-Year Program, which includes research services and other features of inestimable value. Be sure to visit this interesting Britannica exhibit, where you may inspect the latest, 1949 copyright. You will receive a colorful booklet which tells you more about *Encyclopaedia Britannica.*

Gamma Scientific Company (Booth 44). The Gamma Exhibit will feature a variety of scientific instruments and laboratory apparatus such as Micro Balance, Rapid Industrial Balance, Chemical Micro Manipulator, Photomicrographic Camera, Metallographic Microscope, Polarimeter, Refractometer, etc. We call your special attention to the Oertling Micro Balance made in England and recently introduced in this country. This balance actually permits reproducible readings to .001 mg. All models shown are either being exhibited for the first time or represent design improvements introduced within the last year.

General Biological Supply House, Inc. (Booths 63 and 64). The exhibit of General Biological Supply House, Inc. will include a wide range of teaching materials for the biological sciences. Living forms, such as Volvox, Pandorina and other flagellates, will be shown through microprojection. New unbreakable rubber anatomical models will be displayed, as will be many new biological charts. Microscope slides and Kodachrome lantern slides will be available for examination and for projection. The exhibit will also include many living and preserved plant and animal specimens, and the latest developments in field collecting equipment.

Grune and Stratton, Inc. (Booth 80). Among the many books in the scientific and medical fields published by Grune & Stratton, the following recent publications will be of particular interest to those attending the convention: Linksz, *Physiology of the eye*, Volume I: *Optics*, which will be followed shortly by two more volumes dealing with physiology of vision and biochemistry of the eye; Penrose, *Biology of mental defect*; Vannotti and Delachaux, *Iron metabolism and its clinical significance*; Rappaport, *Rapid microchemical methods for blood and cerebrospinal fluid examinations*; Ponder, *Hemolysis and related phenomena*; Davis, *Shock and allied forms of failure of the circulation*. Advance material on a new periodical, *Circulation*, the journal of the American Heart Association, will be available as well as recent issues of *Blood*, the journal of hematology, and the several important special issues of *Blood*.

Harper & Brothers, Publishers (Booth 46). On display will be the new and standard publications of Harper & Brothers and their medical department, Paul B. Hoeber, Inc. The majority of the titles featured in the exhibit are selected texts and reference books from the fields of botany, zoology, medicine, geology, mathematics, engineering, chemistry, psychology, sociology, and education. Also available for examination are recent popular books of special interest to the scientist and to the educated layman. Representing the company at the booth will be Kenneth B. Demaree, Robert G. Hawley, Paul B. Hoeber, Jr., and Edward W. Nichols.

International Business Machines Corporation (Booths 11, 12, and 13). International Business Machines will display its new electronic Card-Programmed Calculator, which is its latest commercially produced equipment for the solution of problems involving sequence calculations in the fields of engineering, applied and theoretical science, as well as business and industry. This equipment makes possible the economical solution at high speeds of extensive problems which have hitherto been impractical for many scientists or organizations. The IBM exhibit will be manned by personnel who can discuss the application of this and other IBM calculating equipment to problems in many fields faced by scientists attending the convention and exposition. Also of interest will be the recently announced Electronic Statistical Machine, which is noteworthy because, simultaneously, it sorts, counts, accumulates, balances, edits, and prints statistical information. Built with small or large capacities, the IBM Statistical Machine provides a means of obtaining many types of comprehensive statistical analyses in minimum time. Representatives will also be on hand to discuss the entire line of IBM Electric Punched Card Accounting Equipment as applied to various fields of science and industry. Also displayed will be the IBM Electric Typewriter and IBM Electronic Self-regulated, Time Indicating, Recording and Signaling Systems.

Jarrell-Ash Company-National Spectrographic Laboratories, Inc. (Booth 38). The optical laboratory instruments which Jarrell-Ash Company are exhibiting will feature equipment manufactured by Hilger & Watts, Ltd., Londan, England, and will include a complete outfit for emission spectrochemical analysis, ultraviolet and infrared monochromators and probably ultraviolet and infrared spectrophotometers and a Raman spectrograph with source unit. A new polarimeter reading to .001° and a refractometer reading to .00001, both with glass scales, will be displayed. Jarrell-Ash will demonstrate a new Baker phase contrast microscope in which the condenser diaphragm stop remains the same for all objectives. There will also be the new Cooke Universal microscope, A. O. polarizing microscope and photomicrographic equipment. An Oertling balance with projected scale, reading from .1 mgm. to 1 gram without opening the case will be shown. There will be an assortment of x-ray cameras. Technical personnel will be on hand to demonstrate the equipment. In attendance will be: Richard E. Ashley, Richard F. Jarrell, Howard A. Morrison, Jr., and J. Albert Rudden.

Kahl Scientific Instrument Corporation (Booth 8). The Kahl Scientific Instrument Corporation Exhibit will include: 1—Instruments for marine research such as bottom grabs, underwater current meters to indicate both velocity and direction, plankton nets, and other apparatus used for limnological studies. 2—Meteorological instruments, primarily several new types of electric psychrometers, and mercury-amalgam thermometers ranging down to minus 75° F. 3—Precision Thermometers of the highest quality and accuracy, such as Beckmann Thermometers, Calorimetric Thermometers, Fractional Degree Thermometers. 4—High vacuum apparatus, including a new type mercury diffusion high vacuum pump, 3-stage style, with freeze-out trap. 5—A new type of gas-flow control apparatus, nonmechanical, which can be adjusted to limit the flow of gases to an infinitesimal quantity.

This instrument is provided with a manometer to indicate varying gas pressures in the system.

E. Leitz, Inc. (Booth 52). Leitz will show its new Monocular and Binocular Medical Microscopes and will also show the well-known Research Microscope ORTHOLUX, with built-in illumination, the Universal Microscope and Photomicrographic Apparatus PANPHOT, and the Stereo-Binocular Microscopes after Greenough. Also exhibited will be the Low and High Power Binocular Magnifiers, the Ultropak Illuminator for observation in reflected light, and the Micro-Projector with synchronous objective-condenser changer Model XI-c. Various photomicrographic cameras will also be shown.

Linguaphone Institute (Booth 22). Because international communication on a level of clear understanding is of the greatest importance to scientists, The Linguaphone Institute of New York, publishers of home-study conversational language courses in 29 of the world's most important languages, is proud to exhibit at the AAAS meeting. At its booth, visitors can enjoy a free trial lesson in any language from Afrikaans to Swedish.

J. B. Lippincott Company (Booth 51). Look to J. B. Lippincott Company, Philadelphia, Pennsylvania, for timely, practical and authoritative information—for selected professional books in all fields of medicine and allied sciences, and in education. Here is a continual indication of current trends and needs which serves as the basis for new and revised clinical volumes and textbooks. Here are reports of the outstanding and significant work being done by those making very real contributions to scientific progress.

The Macmillan Company (Booths 65 and 66). The book exhibit sponsored by The Macmillan Company at the December 1949 meeting consists of approximately 800 titles. In addition to undergraduate and graduate textbooks and reference works, there will be a large number of technical and scientific books of interest to the general reader. Books in the fields of various hobbies and avocations—photography, gardening, radio, outdoor life, and others—are represented, as are books of special interest to young readers. The major classifications are agriculture, the biological sciences, chemistry, engineering, history and philosophy of science, home economics, mathematics, medical science, and physics. Mr. Boyd T. Harris, Science Editor, together with other members of the College Department, will represent The Macmillan Company at this exhibit.

McGraw-Hill Book Company, Inc. (Booths 35 and 36). The McGraw-Hill Book Company's exhibit will be comprised of more than 800 volumes, covering every field of modern science. In addition to standard texts and reference work in all fields of natural, physical, and social science, there will be numerous new and revised work of great importance. Specially featured will be ten or more volumes of the National Nuclear Energy Series, sponsored by the Atomic Energy Commission, ranging in subject matter from pharmacology of uranium compounds to electronic techniques in nuclear research, contributed and edited by the scientists who are carrying on the vital developments in our national and university laboratories. Many new texts and reference books in advanced physics, zoology, chemistry, and natural history will also be featured.

McGregor and Werner, Inc. (Booth 79). McGregor & Werner, Inc., 1640 Connecticut Avenue, N.W., Washington, D. C., is a service organization working with and for scientific and technical societies and publishers. The entire staff of trained technicians and salesmen of the Corporation are cleared to handle classified material. The functions the organization offers to the scientific and technical fields are briefly listed below. *Translations:* All Western European languages, Russian and most of the Oriental and some African languages. *Technical Writing:* Instruction, operating, maintenance, and engineers manuals. *Editing:* Editing for content, style, and for press. *Cataloging:* Complete cataloging services from the warehouse bin to the printed catalog. *Indexing and Abstracting:* Indexing for books, catalogs, and abstracting. *Art Work:* Illustration, drafting, and design in any medium. *Copy Preparation for Offset Printing:* Vari-Typer and Proportional Spacing Machine composition for rapid and economical large scale production. *Printing:* Letterpress and offset book printing, reprinting, binding, warehousing, and distribution. Come and see us at Booth Number 79. We may be able to help you solve your publication problems.

G. & C. Merriam Company (Booth 39). The G. & C. Merriam Company exhibit will consist of a sample display of the various publications of the company which we list herewith: *Webster's new international dictionary,* 2d edition, *Webster's new collegiate dictionary, Webster's dictionary of synonyms, Webster's biographical dictionary, Webster's geographical dictionary* (To be published Nov. 14, 1949), *A pronouncing dictionary of American English picturesque word origins.* In addition there will be displayed for distribution copies of various pamphlet material dealing with instruction in and the use of the various books mentioned above. Souvenirs will be provided.

Philip Morris and Company, Ltd., Inc. (Booth 67). Philip Morris and Company will demonstrate the method by which it was found that Philip Morris Cigarettes, in which diethylene glycol is used as the hygroscopic agent, are less irritating than other cigarettes. Their representative will be happy to discuss researches on this subject, and problems on the physiological effects of smoking.

The C. V. Mosby Company (Booth 42). The C. V. Mosby Company of St. Louis will display its varied line of scientific publications. Among the recent reference and text releases will be the following: Anderson *Pathology,* Ackerman-Regaton *Cancer,* Kleiner *Human biochemistry,* Davison *Handbook of materia medica, toxicology and pharmacology,* Kantor *Handbook of digestive diseases,* Campbell *Operative Orthopedics,* Slocum *Atlas of amputations,* Lee *Official preparations of pharmacy,* Regan

The doctor and patient and the law, Francis *Introduction to human anatomy*, Zoethout *Introduction to human physiology*, Zoethout-Tuttle *Textbook of physiology*, Arnow-Reitz *Introduction to organic and biological chemistry*, Whiteford-Coffin *Essentials of college chemistry*, Anthony *Anatomy and physiology laboratory manual*, Vogel *Anatomy and physiology laboratory manual*, and Flitter *Introduction to applied physics*. Visitors attending the AAAS meeting are cordially invited to look over these and other scientific publications on display.

National Geographic Society (Booth 23). The exhibit of the National Geographic Society will feature the display of a selection of natural color slides by automatic projector. The slides cover National Geographic expeditions and were selected from illustrations by staff photographers of the *National Geographic*.

National Spectrographic Laboratories, Inc. (Booth 70). The National Spectrographic Laboratories' representatives will be prepared to discuss the analysis of agricultural materials such as plant tissues and soils and biological samples for their metallic element contents. Charts for the correlation of nutrient balance in plants for ten elements will be shown. Arrangements may be made with the National Spectrographic Laboratory representative for the analysis of your materials in their laboratory. Spectrographic equipment will be shown jointly with the Jarrell-Ash Company in Booth No. 38.

New York Scientific Supply Company, Inc. (Booth 45). The exhibit of the New York Scientific Supply Company, New York, New York, will feature its first showing of Nyssco-Glo Everlasting Biological Models made of rubber composition, as well as Nyssco-Glo Muscular Skeletons. Details of preparations, colored with specially developed luminescent paints, are amazingly clear when exposed to near-violet light (black light), glowing vividly and brilliantly, and becoming visible in all parts of the room, even in diffused light. The exhibit will also include Nyssco Biological Charts, Transpar Plastic Insect Mounts, museum preparations, Economy Tube Life-Histories in solid media, and many other visual aids of interest to the natural scientist. Convention visitors are cordially invited to vist our building at 28 West 30 Street, which is within short walking distance of the exhibit hall.

Nuclear Instrument and Chemical Corporation (Booth 69). The Nuclear booth will display a complete line of instruments for radioactivity measurement and research. The display includes instruments for classroom teaching purposes as well as those for specialized research laboratories. Operating demonstrations of both types of instruments will be shown, as well as pocket size and portable dosimeters and radioactivity monitors. Competent engineers will be available to suggest answers to instrumentation problems or teaching methods.

The Nucleonic Corporation of America (Booth 55). The exhibit of The Nucleonic Corporation of America will include Model RC-1: A compact, light weight instrument, combining count rate meter and binary scale of 64 with panel mounted register; Model RC2T: A compact, light weight instrument combining decade scale of 100, preset and elapsed timer; Model RC1B; Count Rate Meter: A compact, light weight instrument, with 3 ranges; 500, 5,000, 50,000 counts per minute; *Note:* All of the foregoing instruments contain a high voltage supply. Other features on the scaling unit are: scale selection, and preset count, as well as provision for external pre-amplification. Also included are Model RM1: Portable battery operated, very light weight survey meter, containing variable high voltage supply used in surveying for alpha, beta, and gamma radiation; Model GM1W: Geiger Tubes—series of mica end window tubes ranging in thickness from 0.7 mg. per square cm. and up, window diameter 1½″; Model GM1N: Similar to GM1W, except for smaller window area—10/16″, used with portable lead shield for directional detection; and Accessories: Lead shields, sample holders, probes, etc.

Pfaltz & Bauer, Inc. (Booth 56). Pfaltz & Bauer, Inc., Empire State Building, New York, New York, were established in 1900 and since have been an important supplier of scientific instruments and chemicals to laboratories in the educational and industrial field. This firm has been a distributor of Beckman Instruments since 1936—carrying a complete stock of control instruments produced by the National Technical Laboratories, maintaining a well-equipped service department for the scientists' immediate needs. They are sole agents for an important manufacturer of Projection Reading Balances of the Macro and Micro Types as well as Polarimeters, Phase-Contrast Microscopes, Microtomes, etc. Pfaltz & Bauer are also manufacturers of Photo-Electric Instruments—the first to develop the Fluorophotometer for vitamin assays which today is being used by every important laboratory doing this type of work throughout the world. All of these and other instruments will be on display. Their shops are well equipped for development work and they respectfully solicit your valued inquiries.

Philosophical Library (Booth 57). The Philosophical Library exhibit will consist of a series of their publications (books).

Prentice-Hall, Inc. (Booth 15). Visitors to the Annual Science Exposition are invited to examine the books on display at the Prentice-Hall booth. Some of the books on display will be the following new titles and revisions: *Organic chemistry: Brief course* by Ray Q. Brewster; *Life science*, 4th edition by Max W. de Laubenfels; *Introduction to psychopathology* by Lawrence O'Kelly; *Children with mental and physical handicaps* by J. E. Wallace Wallin; *Basic theories of physics* by Peter G. Bergmann; and *Structure and development of the vertebrates* by Florence Moog.

The Rayoscope (Booth 30). The Rayoscope exhibit this year will consist of the regular De Luxe Rayoscope—a microprojector—together with special models of the unit which have been developed especially for use with polarized light phenomena as well as many other specific uses. There will be offered a special circular rotatable and centerable stage which has degrees of rotation marked so that amount of rotation can be easily determined. This stage has a separate centering bearing and rotating bearing. There will be exhibited a special model of the Rayoscope which uses its own screen on which images may be projected and various methods of measurement done with ease. Of course there will be the striking projection of live materials and life processes such as circulation of blood and heart beat. The Rayoscope has now been developed to the point where it is foolproof and easily operated. This, together with portability, durability, absence of bothersome adjustments and servicing, makes the unit a worthwhile addition to any laboratory where an ordinary microscope is used. Look for the booth with the Neon Sign, ''RAYOSCOPE.'' Meet us there.

Rinehart & Company, Inc. (Booth 20). Rinehart & Company, Inc., publishers, are represented by a display of outstanding texts in chemistry, physics, mathematics, psychology, education, and anthropology. The display also includes a number of technical and radio books published under the imprint of Murray Hill Books, Inc., a subsidiary of Rinehart. Visitors are cordially invited to examine these books at Booth 20, Annual Science Exposition.

The Ronald Press Company (Booth 84). Representatives of The Ronald Press Company will be on hand to welcome visitors to its booth in the Annual Science Exposition at the Hotel Statler. The display will include a varied selection of books on the biological and physical sciences, mathematics, engineering, psychology, and related fields. Information about important publications to be issued during 1950 will be available to the visitors.

W. B. Saunders Company (Booth 1). W. B. Saunders Company, Philadelphia, cordially invites you to visit its exhibit booth where you may examine select books in the biological sciences, chemistry, health, medicine, and surgery. Among the newer texts are *The vertebrate body* by Alfred S. Romer; *Principles of animal ecology* by Allee, Emerson, Park, Park and Schmidt; *College zoology* by Hunter and Hunter; *Principles of organic chemistry* by John L. Abernethy; *Theory and practice of quantitative analysis* by Clark, Nash and Fischer; *General endocrinology* by C. Donnell Turner; and *General cytology* by De Robertis, Nowinski, and Saez. Also on display are the new revised editions of the standard texts, *Fundamentals of bacteriology* by Martin Frobisher, Jr.; Fulton's *Textbook of physiology*; Jordan-Burrows' *Textbook of bacteriology*; *Clinical biochemistry* by Cantarow and Trumper; and *Public health and hygiene* by Bolduan and Bolduan; and many other outstanding texts and reference books. Saunders' representatives present are Tyler Buchenau, Clarence Wheeler, James Hughes, Paul Schneider, E. E. Holland, and E. R. Zieber.

Schwarz Laboratories, Inc. (Booth 43). Schwarz Laboratories, Inc. of 202 East 44th Street, New York, New York, consulting chemists and manufacturers of fine chemicals and chemotherapeutic agents, will exhibit samples of their products. Included will be their well-known yeast nucleic acid and derivatives, as well as other biochemicals useful in research and clinical investigations. Recently added chemicals, such as malononitrile, desoxyribonucleic acid, adenosine-5-phosphoric acid, and the new phosphorylated sugar compounds, barium phosphoglyceric acid, fructose-6-phosphate, and glucose-1-phosphate will also be displayed. Any requirements for Schwarz fine chemicals, as well as technical information, will gladly be discussed by our representatives. Our services for problems in food technology will be offered and details given as requested.

Science Library (Booths 73 and 74). The Science Library is administered by the AAAS as an additional service to publishers of books, both exhibitors and nonexhibitors. It has become an integral part of each year's *Annual Science Exposition*. *In the Science Library*, books of all publishers are *grouped by fields of science*, a convenience both to the visitor who is restricting his inspection of books to one category—and to the one who wishes to browse. Among the publishers represented in the Science Library are:

American Association for the Advancement of Science
Academic Press, Inc.
Annual Reviews, Inc.
Appleton-Century-Crofts, Inc.
Blakiston Company
Burgess Publishing Company
Cambridge University Press
Chemical Education Publishing Co.
Chemical Publishing Company, Inc.
Columbia University Press
Comstock Publishing Company
Cranbrook Institute of Science
Dodd, Mead & Company
Thomas Y. Crowell Company
W. H. Freeman & Company
Garlan Publications
Harper & Brothers, Publishers
Harvard University Press
D. C. Heath & Company
Henry Holt and Company, Inc.
Houghton Mifflin Company
Iowa State College Press
Island Press Cooperative, Inc.
Lea & Febiger
J. B. Lippincott Company
The Macmillan Company
McKnight and McKnight
C. V. Mosby Company
New York Association of Biological Science
Thomas Nelson and Sons
Oxford University Press
Philosophical Library
Pitman Publishing Corporation
Reinhold Publishing Company
Rinehart & Company
Scott, Foresman and Company
Stanford University Press
Charles C. Thomas
Frederick Ungar Publishing Co.
University of Chicago Press
Viking Press
John Wiley & Sons, Inc.
Year Book Publishers

Scientific American (Booth 79A). *Scientific American:* An entirely new monthly magazine of the sciences, published under the 105-year-old name. Original articles by workers in all branches of science. Addressed to scientists, engineers, physicians, and to interested and educated laymen. The Editors will be available for consultation during the convention. Inquire at booth or telephone LOngacre 4-0830. Orders will be accepted at the booth for reprints, back issues, and new subscriptions. Address mail inquiries to The Editors, *Scientific American*, 24 West 40th Street, New York 18, N. Y.

Ivan Sorvall, Inc. (Booth 82). The exhibit of Ivan Sorvall, Inc., will feature chiefly the Servall Angle Centrifuges, of which many variations will be on display. This company has pioneered the use of the angle principle in centrifugation, first introduced to laboratories in 1929, thus paving the way for the further development of high speed centrifuges. Present models range from a small clinical machine, carrying ten 15-cc. tubes, to a large capacity machine for four 500-cc. bottles. Of particular interest is a new vacuum-operated centrifuge of 800-cc. capacity, operated at 16,000 rpm. top speed. All models are available with refrigerators. Also on display is the Sterling Automatic Pipettes, chiefly used for dispensing accurately at a rapid rate small amounts of aqueous solutions, in routine laboratory work. This company also manufacturers and distributes the Servall Magnetic Stirrers with new fusiform glass-encased stirring elements, and distributes the Original-Odhner Calculators, claimed to be "the machine to count on"—a handy and low priced calculator for the scientist.

E. R. Squibb & Sons (Booth 10). Vitamin B_{12} Exhibit: The exhibit will portray the studies which led to the discovery of vitamin B_{12}, the development of suitable therapeutic products and the importance of the factor for man and animals. Many investigators working independently after years of experimenting found that liver contained a substance which played an important role for humans, animals, and microorganisms. Before the isolation of this substance, which was named vitamin B_{12}, it was called the antipernicious anemia factor as applied to humans, the *Lactobacillus lactis* Dorner (LLD) factor and the animal protein factor (APF). The workers in the three fields contributed heavily to the isolation of the vitamin. Although some of these names may have wider meanings, there appears to be little doubt that vitamin B_{12} is an important hematopoietic factor for man and a growth factor for animals and certain microorganisms.

Sugar Research Foundation, Inc. (Booth 9). A general selection of Sugar Research Foundation material, scientific reports, and technological information will be available. The Foundation has a number of colored wall charts suitable for primary and secondary general science classes, a strip film on the subject of photosynthesis, and pamphlets on the growth and production of sugar from both cane and beet plants. Sugar Research Foundation sponsors research projects through grants-in-aid to specialists in nutrition, physiology, medicine, dentistry, and biological and organic chemistry. A summary of the six-year program is contained in a directory—*Research in review*.

Tech Laboratories, Inc. (Booth 83). The exhibit illustrates the three main lines of instruments manufactured by the Tech Laboratories, Inc., as follows: (A) a falling ball viscosity meter based upon Stokes's Law, and with electronically timed operation; (B) a line of moisture meters for measuring the moisture content of wood, paper, textiles, dried food products, etc.; (C) a new electrocardiograph of greatly improved design. This instrument is available in two distinct models, viz.: one for general practice and the other for research and laboratory work. The instrument uses an oscilloscope and comes with a special camera for taking permanent records.

The Technicon Company (Booths 2 and 3). This exhibit will again feature the Technicon Automatic Fraction Collector, a fully automatic machine which collects up to two hundred rigidly controlled samples of predetermined fluid volumes. Also featured will be the new Technicon Microscope Lamp, a radical departure from the time-honored conception of microscope lamp design. This will be of great interest to all serious microscopists. Visitors to the Technicon Booth will also have an opportunity to inspect the Autotechnicon, an automatic tissue-processing machine; the Scopicon, a microscopic projector; and the various Lab-Aid Cabinets for slide filing. The Technicon Automatic Pipette Washer, the Technicon Microslide Dryer, the new, improved Technicon Paraffin Knife, and the Technicon Constant Temperature Water Bath will round out the exhibit of Technicon Laboratory Aids.

Arthur H. Thomas Company (Booth 68). On display at the exhibit of the Arthur H. Thomas Company will be: The Miller Kymograph, Small Model (one second contact intervals); Kymograph Miller No. O; Interval Timers (contact intervals one-fifth, one, three, or six seconds) electric motor driven; a Graphic Time Marker; and the Eberbach Electronic Stimulator, a compact, self-contained unit which provides a wide range of repeated, controlled, square wave pulses of fixed duration for physiological and pharmacological experiments and demonstrations.

Tracerlab, Inc. (Booth 37). The Tracerlab exhibit will feature the basic instruments required for a radioactivity laboratory, including the various types of scalers such as the Autoscaler, the "64" Scaler and the new "100" Scaler. Radiation survey meters, using both ionization chamber detectors and Geiger tubes will be demonstrated as well as thin mica end window Geiger tubes, all-glass Geiger tubes and beryllium window tubes suitable for counting x-rays. Other equipment including remote pipetting devices, remote handling tongs, lead bricks, film badges, and miscellaneous specialized equipment for the radioactivity laboratory will be on exhibit.

Triarch Botanical Products and Histoslide Company, Inc. (Booth 77). Dr. George H. Conant of Triarch Botanical Products, Ripon, Wisconsin, and Dr. J. B. McCormick of Histoslide Company, Inc., Chicago, Illinois, have combined their efforts for the 1949 AAAS Science Annual Exposition. We are presenting a booth that will display the finest prepared microslides for the fields of botany, histology, parasitology, and related sciences. You will find in our booth many new and interesting slides that have been prepared by superior techniques *for discriminating teachers.* These slides will be demonstrated on standard microscopes at your pleasure and convenience. If you are interested in anatomical and other models as teaching aids in science we would suggest that you stop to see and inspect an entirely new and interesting series of models prepared by the Histoslide Company, Inc. These models are displayed for the first time and your reaction to them will determine how many additional models will be made available in the future. Dr. Conant and Dr. McCormick look forward to making new friends and renewing acquaintances.

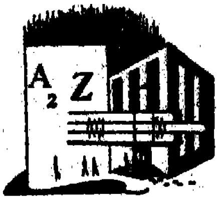
University Presses (Booths 25 and 26). Distinguished for authoritative content and excellence of editorial work, the books of university presses claim enviable rank among nonfiction and technical publications. The American Association of University Presses has arranged a cooperative exhibit for your enjoyment at this meeting—and to give you an opportunity to purchase some of the important titles for your library. Books from the following university presses will be displayed: California, Cambridge, Chicago, Columbia, Cornell, Harvard, Illinois, Iowa, Johns Hopkins, Michigan, Oklahoma, Pennsylvania, Princeton, Rutgers, Stanford, Washington, Wisconsin, and Yale.

D. van Nostrand Company, Inc. (Booth 72). A collection of the newest Van Nostrand publications in the fields of chemistry, nuclear science, biochemistry, physics, biology, and zoology will be featured. Some of these titles include: *Radioactive tracer techniques* (Schweitzer and Whitney), *Crystals and x-rays* (Lonsdale), *Introduction to biochemistry* (Williams and Beerstecher), *Theory and design of electron beams* (Pierce), *Instrumental methods of analysis* (Willard, Merritt and Dean), *Fundamentals of qualitative chemical analysis* (McAlpine and Soule), *A simplified course in elementary qualitative analysis* (Hartsuch), *Introductory biology* (Stauffer), and *Biology and its relation to mankind* (Winchester). In addition, there will be displayed a general line of standard science texts published by Van Nostrand. The display will be housed in a special new traveling unit which Van Nostrand is using for book exhibits.

Ward's Natural Science Establishment, Inc. (Booths 40 and 41). A special feature of the Ward exhibit will be a display of all the new Mueller-Ward and Wilson-Ward models. The new Mueller-Ward models include anatomical-histological models of the liver, kidney, bone, and muscle. The Wilson-Ward line includes models depicting the development of the human face and the development of the human heart. There will also be a complete display of specimens embedded in Ward's Bioplastic. A demonstration of the method of embedding will be made. Other new developments will also be displayed.

W. M. Welch Manufacturing Company (Booths 61 and 62). Featured by the W. M. Welch Manufacturing Company—physical, chemical, and biological instruments and teaching aids—will be new mathematics models; atomic structure model; demonstration radio transmitting and receiving panels; demonstration cathode ray; electronic voltage regulator; and Densichron—an electronic light intensity meter. Other instruments include voltmeters, ammeters, wattmeters, and ohmmeters, a-c and d-c, and demonstration equipment for mechanics, heat, electricity, sound, and light. Charts on display include single charts on "Electromagnetic Waves," "Periodic Table," "Atomic Structure," "Organic Chemistry," and "Isotopes"; and sets of charts for teaching botany, zoology, physiology, aeronautics, and physics.

John Wiley & Sons, Inc. (Booth 6). John Wiley & Sons, Inc., New York, scientific and technical book publishers, is displaying in Booth 6 a comprehensive collection of recent and standard books in various fields of pure and applied science. While stress will be placed on 1949 books, Wiley plans to show a full range of titles which have earned recognition as outstanding texts, manuals, handbooks, or other works of reference. Many of these will be found in new, revised editions. Fields of interest covered include aeronautics, agriculture, anthropology, astronomy, the biological sciences, chemistry, education, the earth sciences, mathematics, public health, physics, psychology, social and political science, and business. Examples of the Wiley visual aids program will be a special feature of the exhibit.



Association Finances

Howard A. Meyerhoff, *Administrative Secretary*

The ensuing condensed statements of Association finances during the years 1946, 1947, and 1948 were prepared by the auditing firm of G. P. Graham & Company and are published herewith, pursuant to a vote of the Executive Committee, in order that the membership may be fully informed regarding the Association's current financial condition.

The first three statements summarize operating receipts and expenditures. It will be noted that, during 1946, the excess of receipts over expenditures was only $10,677, prior to annuity and inflation payments of $22,992 toward the purchase of *Science* and $4,300 for other disbursements. Of the $81,360 shown as the balance of unallocated funds on January 1, 1946, $80,180 was transferred to the Building Fund to complete the purchase of the Scott Circle property. From the precarious situation which resulted at the end of 1946, improvement in the operating balance and replenishment of the Unallocated Funds have been effected by the increase in dues from $5.00 to $6.50, by increased income from advertising and journal subscriptions, and by payment of the 1947 *Science* annuity and inflation allowance from the Treasurer's Funds.

The second series of statements summarizes the status of the Treasurer's Accounts, which include the modest endowment, property holdings and special funds administered by the Association. The list of disbursements gives some idea of the ramified activities for which these funds are used and indicate the expanded service the Association might render if the endowment can be increased.

September 15, 1949

To the Council of the
American Association for the Advancement of Science
Washington, D. C.

We have examined the balance sheet of the Operating Fund of the American Association for the Advancement of Science as at December 31, 1948, and the statement of receipts and expenditures for the years ended December 31, 1946, 1947 and 1948. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying financial statements as supplemented by the notes thereto present fairly the financial position of the Operating Fund of the American Association for the Advancement of Science as at December 31, 1948, and the results of its operations for the three year period ended thereon.

G. P. GRAHAM & COMPANY
By H. A. O'NEILL

American Association for the Advancement of Science
Operating Fund

Balance Sheet as at December 31, 1948

Assets		
Current assets		
Cash	$350,850.16	
Accounts receivable	15,452.69	$366,302.85
		$366,302.85
Liabilities		
Current liabilities		
Accounts payable		$ 27,123.58
Deferred income		
Prepaid dues and fees	$198,694.00	
Prepaid journal subscriptions	46,006.16	244,700.16
Unallocated funds (net worth)		94,479.10
		$366,302.85

Note: The journal *Science* was acquired in 1944 at a stated cost of $106,430.60, payable over a period of ten years, together with such additional as may be determined each year under the inflation clause in the contract. Total payments to December 31, 1948 amounted to $118,299.28. No liability has been shown on the above statement for the balance of $84,140.11 which is payable on the stated cost price of the journal.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
OPERATING FUND

STATEMENT OF RECEIPTS AND EXPENDITURES FOR THE YEARS ENDED DECEMBER 31, 1946, 1947 AND 1948

RECEIPTS	1946	1947	1948
Dues and entrance fees	$135,382.00	$153,546.72	$234,714.73
Journals			
Subscriptions			
From Treasurer's account (life, 50-year and emeritus members)	1,851.00	1,785.00	2,659.50
Members special subscriptions	7,149.00	7,242.00	13,392.75
Non-member subscriptions	35,304.52	41,627.02	50,147.07
Advertising	85,938.85	121,900.11	116,742.84
Miscellaneous sales, etc.	1,983.61	1,834.71	8,115.42
Publications			
Symposium volumes		8,413.34	8,492.15
Proceedings and directory	50.50	9,140.00	22,647.28
Meetings and exhibits	29,181.25	27,404.25	9,768.55
Rental income	1,587.82	3,695.24	3,150.44
Miscellaneous	232.02	2,635.16	815.72
	$298,660.57	$379,223.55	$470,646.40
EXPENDITURES			
Administrative and general expense	$ 47,291.92	$ 47,918.55	$ 58,595.31
Building expense	2,784.48	2,524.18	4,272.71
Executive committee	1,525.18	2,809.77	2,748.12
General secretary	385.48	762.55	750.00
Allowance to divisions	3,699.00	4,384.00	5,183.00
Section expenses	1,311.31	1,691.23	1,455.73
Circularization—new members	1,492.51	4,387.63	26,476.34
Meetings and exhibits	4,865.76	24,219.68	21,432.91
Journals	189,298.99	196,251.98	256,272.26
Publications	33,433.06	18,597.75	42,730.72
Employees' retirement plan			4,723.67
Miscellaneous	1,895.83	2,287.99	1,773.61
	$287,983.47	$305,920.26	$426,414.38
EXCESS OF RECEIPTS OVER EXPENDITURES	$ 10,677.10	$ 73,303.29	$ 44,232.02

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
OPERATING FUND

ANALYSIS OF UNALLOCATED FUNDS (NET WORTH)
JANUARY 1, 1946 TO DECEMBER 31, 1948

Balance as at January 1, 1946			$ 81,360.91
Add:			
Excess of receipts over expenditures			
1946	$10,677.10		
1947	73,303.29		
1948	44,232.02	$128,212.41	
Transfer from reserve for symposium publications as directed by Executive Committee (1947)		17,354.06	
Payments received from Trustees of Estate of James M. Cattell in full settlement of claim affecting prior year (1947)		3,284.83	148,851.30
			$230,212.21
Deduct:			
Amounts paid on Woodley and Stephenson claims and attorney's fee incident thereto		$ 4,300.00	
Amount transferred to building fund—Treasurer's account		80,180.81	
Science annuity payments			
1946	$16,643.04		
1948	16,643.04	33,286.08	
Inflation allowance on annuity			
1946	$ 6,349.82		
1948	11,616.34	17,966.16	135,733.05
Balance as at December 31, 1948			$ 94,479.16

Note: The 1947 *Science* annuity and inflation allowance thereon were paid from the Treasurer's accounts.

September 15, 1949

To the Council of the
American Association for the Advancement of Science
Washington, D. C.

We have examined the balance sheet of the Treasurer's accounts of the American Association for the Advancement of Science as at December 31, 1948, and the statement of cash receipts and disbursements for the three year period then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet as at December 31, 1948, and statement of cash receipts and disbursements present fairly the financial position of the Treasurer's accounts of the American Association for the Advancement of Science at that date, and the cash receipts and disbursements for the three year period then ended.

G. P. GRAHAM & COMPANY
By H. A. O'NEILL

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

TREASURER'S ACCOUNTS

BALANCE SHEET AS AT DECEMBER 31, 1948

ASSETS

Endowment and reserve funds		
Cash awaiting investment	$ 10,875.74	
Securities	236,645.64	$247,521.38
Building fund		
Cash	$ 23,420.90	
Securities	648.20	
Real estate	153,297.20	177,366.30
Current funds		
Cash		20,997.81
		$445,885.49

LIABILITIES AND RESERVES

Endowment and reserve funds			
For research		$118,366.15	
For general purposes		104,617.25	
For special purposes		9,025.00	
Treasurer's reserve fund		15,512.98	$247,521.38
Building fund			
Contributions from members, etc.		$ 97,185.49	
Transfer from Operating fund		80,180.81	177,366.30
Current funds			
Liabilities			
Thousand dollar prize fund	$ 2,000.00		
Special academy grants	400.00		
Westinghouse science writers award fund	1,153.44		
AAAS—UNESCO fellowship fund	53.50		
Academy grants	2,524.75	$ 6,131.69	
Unappropriated income			
For research	$ 3,348.23		
For general purposes	2,929.70		
Unallocated	235.16		
Jane M. Smith fund	1.09		
Luella A. Owen fund	13.95		
A. G. Stillhamer fund	538.98		
Unexpended balances of previous years	7,799.01	14,866.12	20,997.81
			$445,885.49

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

TREASURER'S ACCOUNTS

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS JANUARY 1, 1946 TO DECEMBER 31, 1948

Cash balances January 1, 1946			$ 38,132.40
Receipts			
Endowment and reserve funds			
Life membership fees			
Regular	$ 4,700.00		
Emeritus (Jane M. Smith fund)	4,500.00		
Income added to reserve fund	2,259.13		
Redemption and sale of securities	180,462.18	$191,921.31	
Building fund			
Amount due from Operating fund Jan. 1, 1946	$ 48,604.36		
Contributions	47,241.63		
Liquidating dividend on securities	700.00		
Income from securities	54.15		
Transfer from Operating fund	80,180.81	176,780.95	
Current fund			
Contributions for special academy grants	$ 950.00		
Westinghouse science writers award fund	14,574.94		
AAAS—UNESCO fellowship fund	53.50		
Deseased emeritus life membership fees—Transferred from endowment fund	2,000.00		
Thousand dollar prize fund	2,000.00		
Net income from securities	20,437.30	40,015.74	408,718.00
			$446,850.40
Disbursements			
Endowment and reserve funds			
Securities purchased	$166,433.93		
Deceased emeritus life membership fees—Transferred to Jane M. Smith fund income	2,000.00		
1947 Science annuity and inflation allowance thereon (Note A)	26,279.36	$194,713.29	
Building fund			
Cost of properties and additions	$153,297.20		
Miscellaneous expenses and refunds	61.05	153,358.25	
Current fund			
Westinghouse science writers award fund	$ 20,899.00		
Special academy grants	600.00		
Thousand dollar prize fund	2,000.00		
Emeritus life members (Jane M. Smith fund income)	4,500.00		
Income allocated to Treasurer's reserve	2,259.13		
Academy grants	6,866.75		
Journal subscriptions (Life, 50-year and emeritus members)	6,295.50		
Miscellaneous expenses	64.03	43,484.41	391,555.95
Cash balances December 31, 1948			
For investment		$ 10,875.74	
For building fund		23,420.90	
For current purposes		20,907.81	$ 55,294.45

Note: (A) *Science* annuities and inflation allowances thereon for the years 1946 and 1948 were paid from the Operating fund of the Association.

TECHNICAL PAPERS

The Antitreponemal Effect of Oral Chloromycetin[1] in 32 Cases of Early Syphilis in Man—A Preliminary Report

Monroe J. Romansky, Sidney Olansky,
S. Ross Taggart, and Eugene D. Robin

Department of Medicine, George Washington
University School of Medicine, and
Gallinger Rapid Treatment Center,
Bureau of Venereal Disease,
Washington, D. C.

Chloromycetin (Chloramphenicol) was originally isolated from a soil organism, *Streptomyces venezuelae* (*1*). This antibiotic has been shown to have a wide range of therapeutic activity against many pathogenic organisms.

A systematic study of its use in the treatment of human syphilis has not yet been reported. However, it has been used by Smith and co-workers (*4*) in the treatment of experimental rabbit syphilis. These workers found that after dosages of 50 and 100 mg/kg of body wt the syphilitic lesions were cleared only temporarily of treponema.

Smadel and associates (*3*) reported that a single oral dose of chloromycetin would cure a high percentage of acute gonorrheal urethral infections. They suggested that chloromycetin might not have the effect of masking syphilitic infections and thus might be more desirable than penicillin for the treatment of gonorrhea.

Since the use of chloromycetin in the treatment of gonorrhea has been reported and since it seemed to have some antitreponemal activity in rabbit syphilis, we decided to study its effect upon the treponema of human syphilis.

Patients with lesions containing numerous *Treponema pallidum* were selected for this study. The first four cases received 120 mg/kg of chloromycetin per day. Two of these received an additional priming dose of 4 g. The next four patients received 60 mg/kg/day, and the remaining 24 received 30 mg/kg/day. Except in a few instances the antibiotic was administered orally in six equal doses at 4-hr intervals. Table 1 summarizes the treatment schedules and clinical and laboratory data of

TABLE 1

EFFECT OF CHLOROMYCETIN IN 25 CASES OF EARLY SYPHILIS IN MAN

No. of cases	Diagnosis	Chloromycetin mg/kg /day	Days treatment	Total dose in g	Darkfield negative in hr	Serologic titer				Remarks
						Before treatment	Months after treatment 1	2	3	
3	S*	120	6	56.0		1 : 256	1 : 4	NF‡	1 : 4	
	"			51.0	22–26	1 : 128	1 : 64	NF	NF	priming dose 4 g
	"			50.0		1 : 128	2 +	neg	NF	
3	S	60	6	44.5	23–24	1 : 512	1 : 64	1 : 16	1 : 8	
	P†			18.0		neg	neg	neg	neg	
	"			27.0		neg	neg	neg	neg	
19	S	30	4, 6, or 8	20.5		1 : 1024	1 : 128	1 : 32	NF	
	"			10.5		1 : 256	1 : 64	NF	NF	
	"			18.5		1 : 256	1 : 16	NF	NF	
	"			10.5		1 : 128	1 : 32	1 : 4	NF	pregnant
	"			16.0		1 : 128	1 : 64	NF	NF	
	"			12.0		1 : 128	1 : 16	1 : 16	NF	
	"			12.0		1 : 128	1 : 128	1 : 128	NF	
	"			12.0		1 : 64	1 : 32	1 : 4	NF	
	"			12.0		1 : 64	1 : 16	1 : 4	NF	
	"			12.0		1 : 64	2 +	neg	NF	
	P			27.5	22–28	3 +	neg	NF	NF	12 g on 1st day
	"			12.0		neg	neg	neg	NF	
	"			22.0		neg	neg	neg	NF	15 g on 1st day
	"			22.0		neg	neg	neg	neg	12 g single dose on 1st day
	"			18.0		neg	neg	neg	neg	
	"			8.0		neg	NF	neg	NF	
	"			12.0		neg	neg	neg	NF	pregnant
	"			8.0		neg	neg	neg	neg	
	"			8.0		neg	neg	NF	NF	
25	(total)									

* Secondary syphilis.
† Primary syphilis.
‡ NF indicates no follow up.

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[1] The chloromycetin (Chloramphenicol) used in this study was obtained through the courtesy of Parke, Davis & Company, Detroit, Michigan.

25 of the patients treated. Seven additional patients were treated but could not be followed up.

Treponema were not found in the lesions of the first four cases 22–26 hr after treatment was started. The treponemal disappearance time in the next four patients was 23 hr. Two cases given 30 mg/kg/day were negative in darkfield microscopic examination in 26 hr.

Since there was rapid disappearance of the treponemas from the local lesions on a relatively large dose it was decided to investigate the minimal effective dose of the antibiotic. A single oral dose of 250 mg was given to three cases, the lesions remained positive for treponema in darkfield examination even at 48 hr. Two cases were given 500 mg in a single oral dose; the lesions in one became negative in darkfield examination in 48 hr, and the other remained positive even at 96 hr. In these cases treatment was subsequently instituted on a 30 mg/kg/day schedule for 6 days with complete healing of the lesions.

In order to determine whether the treponemal disappearance time could be decreased, one case was given 2 g every 4 hr for six doses, a second case 2.5 g every 4 hr for six doses, and a third case 12 g as a single dose; the trepomenal disappearance time was 24, 26, and 24 hr, respectively. Apparently increasing the dose of chloromycetin does not appreciably shorten the treponemal disappearance time.

These findings suggested that an oral chloromycetin dosage of 30 mg/kg/day divided into six doses and given at 4-hr intervals might be effective in the treatment of early syphilis. Therefore, a total of 24 patients were treated with 30 mg/kg/day for 4, 6, or 8 days. The lesions in all cases showed evidence of initial healing within 24 hr and most of them showed complete healing by the end of therapy. Some delay in healing occurred in a few cases where the location of the lesion predisposed to a slower response. For example, a patient with a urethral chancre took 6 days to heal because of the constant flow of urine over the lesion.

Chloromycetin seems to us to promote healing by a different mechanism from penicillin. Penicillin produces initial healing at the periphery of a lesion, whereas healing with chloromycetin therapy seems to be initiated from the base of the lesion. This is particularly striking in the large ulcers of benign late syphilis of the skin.

Quantitative serologic tests using the Eagle Flocculation Test for syphilis were performed prior to therapy and at monthly intervals after treatment. It is noted in the table that there is a rapid decline in serologic titer in most cases at the end of one month following treatment.

Two of the patients who received 30 mg/kg/day were pregnant. The clinical and serological response until now has been satisfactory in both patients. One patient has delivered a live child. Although serologically positive at birth, clinical and serologic progress in this child have been excellent without further therapy. The second patient is still pregnant.

The only toxic or untoward reactions noticed with the dosages of chloromycetin utilized in this study were an occasional mild diarrhea and an occasional complaint of dryness of the mouth. The Jarisch-Herxheimer reaction in chloromycetin-treated patients is either less frequent than that observed in penicillin-treated cases or of such a mild nature that it is frequently missed. Only two patients were observed to have very mild reactions 48 hr after treatment was started. Several patients complained of a generalized aching sensation 48 hr after treatment began, but no fever or eruptions were noted. As these symptoms disappeared in 8–12 hr, despite further therapy, they may have been Jarisch-Herxheimer reactions.

Since relatively small doses of chloromycetin will cure acute gonorrhea, (*2*, *3*) attention should be called to the possible danger of masking the diagnosis of syphilis.

Studies with the use of chloromycetin for the treatment of syphilis are continuing, and are being extended to include the late manifestations of syphilis. One patient with late syphilis manifested by extensive gummata of the leg is now under therapy with chloromycetin. This patient has had a dramatic healing response within 4 days after treatment was started.

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Effect of Pressure on Induction of Mutations by Nitrogen Mustard[1]

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An analysis of the mechanism of action of mutagenic agents depends, for the most part, upon indirect experimental methods (*1*). By studying changes in the mutation rate under varying experimental conditions, such as temperature and pH, it has been possible to obtain some idea as to the general stability of genes. Since nucleoproteins are apparently the most important components of the chromosome (*5*) (and presumably of the genes), it is likely that structural changes in these molecules underlie the basic alterations involved in gene mutation. Such structural changes might be of the order of magnitude observed by Johnson, Eyring, and collaborators in protein denaturation (*14*). Since pressure has been used successfully in the analysis of such equilibria or rate processes by these workers, it seemed to the authors that a similar study of the effect of pressure on the mutagenic action of the nitrogen mustards would aid materially in interpreting the results which have been obtained with these and similar agents. According to the general expressions which have been derived for a quantitative interpretation of the effect of pressure on biological processes (*8*), it should be possible to determine the magnitude of the volume change which occurs during the reaction that results in a gene mutation.

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A series of experiments have been performed to determine the effect of high hydrostatic pressure on the induction of both morphological and biochemical mutants in *Neurospora crassa* by nitrogen mustard. The results, summarized in Table 1, clearly show that application of high pressure to a conidial suspension containing nitrogen mustard depresses the number of morphological mutants obtained ($P < .001$). The reduction of the mutation rate is directly proportional to the pressure applied. With 9,000 lb per sq in. (psi), the rate of morphological mutation is reduced approximately 45–50%, while with 5,000 psi the rate is reduced approximately 30–35%. A few experiments performed at a pressure of 2,000 psi indicate that approximately 10% reduction occurs at that pressure. A record of the different types of morphological mutants which occurred was kept, and the results indicate that no particular sort of mutant was suppressed by the high pressure. The mutants recovered after subjection to mustard plus 9,000 psi were of the same general types as those recovered after treatment with mustard at normal atmospheric pressure. Results obtained with different pressures may be compared, therefore, on a rate basis.

By making use of the following general equation, the volume change of a reaction can be determined by plotting the *ln* of the velocity constant against pressure:

$$\left(\frac{d\,ln\,K}{dp}\right)_T = \frac{\Delta V}{RT}$$

From a plot of the *ln* of the morphological mutation rate against pressure, the present data indicate that an average volume change for the individual event occurring in the chromosome is approximately 70 cm^3 per mole, a volume change which is similar to that found for denaturation of serum globulin (*11*), for inactivation of specific antitoxin (*12, 13*), and for specific precipitation (*4*).

Pressure appears to have an opposite effect to that just described when, instead of morphological mutants, chemical mutants induced by nitrogen mustard are tabulated. In all experiments there is a consistent increase in the number of biochemical mutants obtained when pressure is combined with nitrogen mustard. On the basis of kinetic analysis this relationship indicates that changes which result in the formation of a biochemical mutant proceed with a decrease in volume. Additional experiments will be necessary to establish this point definitely.

The differential effect of pressure on the induction of morphological and biochemical mutants by nitrogen mustard is of particular interest because it confirms previous indications that these two types of mutants are different in nature. Experiments combining the effects of ultraviolet radiation and nitrogen mustard have shown that a difference between these two types of mutants exists (*15*). A large percentage of the morphological mutants are sterile, a fact indicating that probably the phenotypic effect is due to gross chromosomal changes; whereas biochemical mutants, on the other hand, usually require single growth factors and have been shown, in many cases, to be due to single gene changes (*3*). It is not surprising that pressure has such a marked effect on the rate of morphological mutations if most of them are due to chromosomal breaks. Such rearrangements of the nucleoproteins would be expected to be accompanied by large volume changes. It should be emphasized that although our results show a significant decrease in the number of morphological mutants at high pressure, the percentage of viable spores is not significantly altered. This indicates that the killing action of the mustard is not inhibited by the pressure.

The possibility that cross-linking plays a role in the action of mustard gas has been suggested (*6, 10*). Elmore *et al.* have found that the number of blocked titratable groups in thymus nucleic acid is greater than the number of mustard gas residues in the molecule. Their results indicate that the mustard gas molecule reacts with two titratable groups either in the same molecule or, by cross-linkage, between different polynucleotide chains. The increased viscosity they observed in the treated sample also suggested the existence of intermolecular cross-linkages. Goldacre *et al.* further suggested that nitrogen mustards produce their effects by interchromatid cross-linkages, which result in fragmentation and consequently in rearrangement. It seems likely that such extensive rearrangements of the nucleoproteins in the chromosome as that which results after treatment with nitrogen mustards may be the basis of the morphological effect observed in subsequent generations. Furthermore, it is to be expected that these particular reactions would be accompanied by large volume changes and that pressure would influence the process significantly.

The effect of pressure on the process yielding biochemical mutations indicates that such an extensive rearrangement of genic material does not occur in this case. The evidence suggests, on the contrary, that such mutations are accompanied by a volume decrease, such as might be expected to occur with a simple bimolecular reaction (*7*). A more extensive analysis of the effect of pressure to include not only single gene mutations but also small deletions involving several genes must be of great interest. It may be that changes which result in a single gene mutation are greatly delayed and occur only at the time of the reduplication process. Combination of nitrogen mustard with groups at the surface of the chromosome or gene may perhaps take place with a small volume change; however, if the genes have to unfold in the reproduction process, as has been suggested (*9*), it is possible that exposure of new groups at that time to the attached nitrogen mustard molecule might greatly influence the unfolding process. Analysis of delayed effects of pressure should throw light on the nature of this process.

Experiments have been performed to determine whether pressure would have an effect if applied after mustard treatment. In these experiments treated spores were centrifuged and resuspended in phosphate buffer and immediately placed under pressure. If 9,000 psi are applied within 10–15 min after the treated spores have been resuspended in phosphate buffer, it is possible to reduce the number of morphological mutants by approximately 25%, in contrast to the 45–50% reduction observed when pressure is applied simultaneously with mustard. Thirty min after treatment the mutation process appears to have become irreversible insofar as morphological mutants are

TABLE 1

EFFECT OF PRESSURE ON INDUCTION OF MUTATIONS BY NITROGEN MUSTARD IN *Neurospora crassa* (TEMP = 26° C)

Exp. No.	Treatment	No. isolations	No. morph. mutants	% Mut.	No. biochem. mutants	% Mut.	% Kill
21	0.2% Mustard	357	53	14.9	3	0.8	99.57
	0.2% Mustard + 9000 psi	238	17	7.2	6	2.5	99.94
25	0.2% Mustard	396	45	11.4	4	1.0	99.20
	0.2% Mustard + 9000 psi	435	33	7.6	8	1.8	99.72
48	0.2% Mustard	423	82	19.4	8	1.9	....
	0.2% Mustard + 9000 psi	377	46	12.0	10	2.7	....
53	0.2% Mustard	329	49	15.0	..	..	....
	0.2% Mustard + 9000 psi	595	44	7.4	..	..	....
29	0.2% Mustard	323	27	8.3	..	..	98.27
	0.2% Mustard + 5000 psi	377	20	5.3	..	..	98.50
39	0.2% Mustard	513	63	12.3	4	0.8	....
	0.2% Mustard + 5000 psi	448	36	8.0	5	1.1	....
	None	400	5	1.4	0	0	....
	9000 psi	385	3	0.8	0	0	50.00

concerned, for pressure applied at that time has no appreciable effect. The results therefore indicate that there are temporary delayed effects of nitrogen mustard which can be influenced by application of high hydrostatic pressure.

From the type of temperature and pressure analysis which has been adequately outlined by Johnson, Eyring, and their co-workers, it should be possible to obtain a clearer understanding of the action of chemical agents and various types of radiation in inducing genic changes. The action of pressure on the combined effects of various mutagenic and nonmutagenic agents (N-mustard, x-ray, ultraviolet, and infrared radiation, etc.) may be expected to clarify greatly the process by which these environmental factors can modify the mutation process.

A microconidial strain of *Neurospora crassa*[3] *(2)* was used to study the effect of pressure on the induction of both biochemical and morphological mutants by nitrogen mustard, bis-β-chloroethylmethylamine. Eight-day-old conidia were suspended in 0.1 M phosphate buffer (pH 6.5) and filtered through a sterile pad of cotton in order to remove any mycelial fragments. After the desired treatment, the spores were plated onto a complete medium containing 1.5% L-sorbose *(16)*. After 2–3 days, single isolates were transferred to small (10 × 75 mm) complete slants and subsequently scored for morphological mutations. These isolates were then transferred to a liquid minimal medium to determine the presence of any biochemical mutants. Most such mutants found involved deficiencies of single amino acids, vitamins, or purines.

The method used in applying high pressure to the conidial suspension was essentially that which has been described by Johnson *et al.* *(14)*. The desired amount of an aqueous solution of nitrogen mustard was mixed with the conidial suspension, and a sample of the mixture was placed in the high pressure bomb. In those cases where pressure was applied simultaneously with the mustard, there was a lapse in time of approximately 30 sec between mixing of the mustard with the conidial suspension and application of the pressure. After treatment under high pressure, a sample of the mixed suspension was removed from the pressure bomb and rapidly plated onto the complete medium.

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[3] Kindly supplied by Dr. E. L. Tatum.

A Prediction Regarding the Humboldt Current

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According to a finding of the late E. G. Mears, an unusual ice outbreak was due in the North and South Atlantic during the proper seasons of 1949. The Humboldt Current should begin receiving warm water invasions by the southern summer of 1950, but these invasions should not become serious until 1951–52. Dr. Mears' attention was drawn to the Humboldt Current during the 1941 conference of scientists in Lima. In *Science* *(16)* of April 24, 1942, he pointed out that the 1941 tropical intrusion *(9)* into the normally subtropical Peru, did not correspond to the seven-year cycle *(24)*, which had been proposed previously, for only two years had elapsed since the 1939 interruption had occurred. In Dr. Mears' subsequent study of the Humboldt Current, he became confident that the disastrous warm water visits to the coast of Peru are occasioned by tides, (*5*, *7*, *12*, *15*, *18*, p. 334, *23*, *25*, *26*). They are connected with moon cycles (*23*, *25*, *26*) and are related to sunspot activity indirectly as the sunspots affect the moon (*2*, *19*, *22*, *23*, *32*, *33*, *36*).

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[1] Research Assistant to E. G. Mears, 1940–1946.

Pettersson, of the Hydrographic Station of Borneo, has shown that tides at boundaries between deep and bottom waters of deep inlets during certain moon cycles are as much as fifty times greater (*25*, *26*) than simultaneous tides at the surface. Therefore, even though polar region tides at the surface are small (*12*), in deep polar inlets tides at boundaries between deep and bottom waters may be very important, for Pettersson has proved (*25*, *26*) that it is because of these tides that important ice outbreaks come from such inlets. He suggested in 1929 (*26*) that ice outbreaks from such inlets in the immediate antarctic vicinity of the Humboldt Current might cause the tropical irregularities in the Humboldt Current area. When Gunther (*10*) demonstrated that antarctic water had no part in the Humboldt Current either directly at the surface or from upwelling, and other *Discovery Reports* (*4*, *6*, *8*, *13*, *14*) made clear that only the Weddell Sea had an outlet sufficiently deep to emit significantly large quantities of ice (*30*, *35*), it became apparent that Pettersson's suggestion needed to be amplified. Dr. Mears, in a manuscript he was preparing for publication when he died, stated that ice from the Weddell Sea seemed to fit known occurrences better than ice from the immediate antarctic vicinity of the Humboldt Current could, because there appeared to be a lag between ice outburst and abnormalities in the Humboldt Current area. If the ice discharge came into the immediate stream from which the Humboldt stems—the West Wind Drift— the lag of approximately a year between unusual ice conditions known in the antarctic and any disturbance in normal phenomena of the Humboldt Current area, and two to three years before serious interruption occurred, would be difficult to explain (*23*). This lag, if the significant ice discharge comes only from the Weddell Sea, would be necessitated by the long circuit which the body of water affected by the discharge from the Weddell Sea must make around the Antarctic Ocean to the American West Coast before it could affect the Humboldt Current environs.

That the ice discharge from the Weddell Sea is important is attested by Mackintosh and Herdman (*14*, p. 292): "The Weddell Sea has an important effect in the distribution of ice in the Atlantic sector . . . the flow of cold water from the Weddell Sea . . . exerts an influence far to the east. . . . The Ross Sea, which is shallow and has a less effective current system, has comparatively little influence on the ice beyond its immediate neighborhood." Deacon (*6*) stated that in the Weddell Sea deep and bottom water could be renewed from the surface. From the oxygen and mineral contents of the deep and bottom waters in the eastern Pacific area, Clowes (*4*) agreed with Deacon that the Weddell Sea appeared to be the only place, or the only significant place as far as the Southern Ocean Drift is concerned, where deep and bottom water can be renewed. Since ice conditions from the Weddell Sea affect the circumpolar drift significantly, and conditions in the Weddell Sea can affect the oceanic water from the surface to the bottom, tides at the boundaries between deep and bottom water layers might affect surface water conditions and force unusual ice discharges from the Weddell Sea, even as Petterssou suggested. Dr. Mears suggested that an unusual discharge of ice and abnormal amounts of deep and bottom water from the Weddell Sea might affect, for the complete circuit of the drift, the portion of the circumpolar drift into which it was emitted. Since most of the deep and bottom water of the great polar drift does not seem to cross the South American submarine ridges, but apparently turns to the northward on approaching the American continent (*1*, *4*, *6*, *8*, *14*, *29*, *34*, *41*), the Humboldt Current normally rides to the northward over a huge mass of generally northward-moving water (*10*). If this huge mass had unusual augmentations, such as Petterssou (*25*, *26*) described as resulting from certain moon cycle tides in deep inlets, that huge mass might be crowded upward as it made its way northward between Easter Island Ridge (*30*, *38*) and the coast of South America, in Thoulet's Easter Island Sea (*38*). As the crowded water pushes upward, everything above, including the Humboldt Current, must make adjustments. The partial loss of equilibrium at such times in the Humboldt Current's more or less steady northward flow would not be surprising. According to Schweigger (*31*), that is exactly what the Humboldt Current appears to do at periodic intervals, which, as Dr. Mears (*18*, *23*) pointed out, seem to coincide with moon rather than sun cycles.

Because the significant ice discharge and attendant phenomena take place as far removed as possible in the circumpolar drift from the Humboldt Current area, there must be a distinct lag between interrelated occurrences, if there be interrelationship. The data are far too few for conclusive statements, but those few data seem to point to a lag of about a year after the unusual ice outbreak before the abnormalities in the Humboldt Current area begin to manifest themselves. It is about the third year before serious interruptions of normal conditions occur. An unusual ice outbreak came from the Weddell Sea in 1930 (*14*, p. 292) according to Mackintosh and Herdman, who were in the region at the time. Yet 1930 was a normal year in the Humboldt Current (*31*) according to Schweigger, of the Peruvian Fisheries Department, who was investigating the Humboldt Current over the period from 1928 to 1941. It was not until 1931, the year of Gunther's careful oceanographic examination of the current (*10*), that abnormal conditions tended to arise and not until 1932 that a serious interruption of cool weather conditions in Peru occurred (*31*). In 1938 ice was again exceptionally bad in the Weddell Sea outlet and its approaches (*14*, p. 292); in 1939 there were warm water invasions into the usual path of the Humboldt Current; but conditions along shore and throughout coastal Peru were not affected seriously until 1941 (*9*, *17*, *19*, *20*, *21*, *31*), the third year after the ice outbreak from the Weddell Sea. Data regarding ice from the Weddell Sea before the disastrous years of 1891 and 1925 in the Humboldt Current region are not available to the writer.

Pettersson (*26*) stated that the tides affected the North Atlantic through the deep passages from the Arctic during the same year they did the South Atlantic from the Antarctic. The U. S. Ice Patrol (*40*) reported in 1922 that "the berg menace existed this year later than during any season since the patrol was taken over by the Coast Guard in 1914. . . . The presence of these [eleven] bergs so far south [around 43 degrees north latitude] is difficult to understand as we have had almost continuous southerly winds for the past month" (*40*, No. 10, p. 41). The third year after the unusual North Atlantic ice conditions in 1922 came the 1925 disaster in Peru. In 1938 the ice outbreak from the Arctic was again unusual (*40*), as it was from the Weddell Sea (*14*). Data fail regarding ice before the Humboldt Current debacle of 1891. But Tebbutt, of the Sydney Observatory, noted a tide during the southern winter of 1889, which was so high for three successive nights that the new gages could not measure it (*37*). The third year after these excessive tides came the notable invasions of tropical conditions and the resultant death to the abundant subtropical life in the Humboldt Current area (*3*, *28*).

When ice and sea tide data fail, another suggestion of Dr. Mears' (*22*, *23*) appears: there are tides in the air (*2*, *23*, p. 101, *33*, *36*) and at air layer boundaries, these tides may be as significant as they are at boundaries between sea layers (*22*, *23*). Certain it is that at normal times the cold arctic air masses do not seem able to escape over the Rockies (the great cordillera which under various names reaches from the Aleutians to Panama in North America) into the Pacific coastal region (*23*, pp. 29, 114–5). During significant years, 1922, 1937 (winter), 1889 (January and February), such escapes did occur (*41*) with appalling economic results to Californians from freezing. In 1922 and 1937 the air effect came previous to the ice outbreak. If tides cause both, the effect on the air would be immediate; that upon the ice might be delayed. In 1922 and 1937 the California freezes came first; the ice outbreaks came in the following seasons, in the North Atlantic, both during 1937 and 1938 (*40*); in the Humboldt Current, serious abnormalities came the third year following.

During the winter of 1948–49, the arctic air masses made their breaks over the Rockies into California. If events follow as they seem to have followed in 1889, 1922, and 1937, and as Dr. Mears suggested they may continue to follow in accordance with moon cycles, unusual ice outbreaks were due in both the North and South Atlantic in the proper seasons of this year, 1949. The Humboldt Current should begin to have abnormalities during 1950; it should have serious interruptions during the summer of 1951–52.

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NEWS and Notes

Science Writing Awards

Lester Grant, science reporter for the *New York Herald Tribune,* and **George W. Gray,** a free-lance writer living at Sparkill, New York, today were named winners of the fourth annual George Westinghouse Science Writing awards of $1,000 each for the best science writing of 1949. The awards will be presented at a luncheon in honor of the writers on December 28 in New York City during the annual meeting of the AAAS, which administers the awards.

Mr. Grant will receive the award for what was adjudged the best newspaper science writing of the year, a series of 15 articles entitled "The Challenge of Cancer," published by the *Herald Tribune* June 6 through June 20, 1949. The magazine writing award went to Mr. Gray for his article on the human brain, "The Great Ravelled Knot," in the October 1948 issue of *Scientific American,* a work the judges considered the best magazine science writing during the contest year (August 1948 through September 1949). There were 75 entries in the news writing competition and 108 in the magazine field.

Honorable mention in the magazine field was voted by the judges to **Herbert Yahraes,** a free-lance writer of Stanfordville, New York, for his article, "How to Keep Away From the Dentist," which appeared in the March 1949 issue of *Harper's Magazine.*

Although Mr. Grant said later he had worked harder on the cancer series than on any previous science writing, he had not originally entered his series. Late in September John W. Tietz, of the Department of Biology, De Witt Clinton High School in New York City, wrote to the AAAS suggesting that the cancer series be considered. Asked if he did not wish to enter the competition in view of the nomination by an AAAS member, Mr. Grant submitted the cancer series on October 7—only 24 hours ahead of the deadline. Mr. Yahraes' article was submitted by *Harper's* and he then withdrew another article he previously had entered. Both Mr. Grant and Mr. Yahraes had been Nieman Fellows at Harvard, Mr. Grant in 1948 and Mr. Yahraes in 1943.

Mr. Grant, at 36, has been a newspaper man for 19 years and science reporter on the *Herald Tribune* for three years. He was born in Taft, California, but calls San Francisco his home town.

Mr. Gray is 63. Born in Caldwell, Texas, he has been a free-lance writer for many years. His articles have appeared in *The Atlantic Monthly, Harper's, This Week, The Yale Review, The American Magazine, The New York Times Magazine,* and *Scientific American,* among others. He was graduated from Harvard in 1912.

Judges this year, chosen as representatives of the general public, science, newspapers and magazines, were: Morris Meister, retiring president of the National Science Teachers Association and principal of the Bronx (New York) High School of Science, *chairman*; Henry R. Aldrich, secretary, Geological Society of America; Detlev Bronk, president, The Johns Hopkins University, and chairman, National Research Council; Kent Cooper, executive director, The Associated Press; John R. Dunning, nuclear physicist, Columbia University; Clifton Fadiman, a member of the board of judges of the Book-of-the-Month Club; Rudolph Flesch, readability consultant, and Edward Weeks, editor, *The Atlantic Monthly.*

Previous winners of the $1,000 award for newspaper science writing are James G. Chesnutt, of the *San Francisco Call-Bulletin,* George Keaney, of the *New York World-Telegram,* and Frank Carey, science reporter in the Washington Bureau of the Associated Press. Previous winners in the magazine field are Steven M. Spencer, associate editor of *The Saturday Evening Post,* and Dr. Florence Moog, St. Louis scientist and writer.

The awards were established in 1946 to stimulate interest among young writers in making careers of science writing, and to encourage high standards of science writing in newspapers and magazines.

About People

Vannevar Bush, president of the Carnegie Institution of Washington, has been elected a director of Merck and Company, Inc., manufacturing chemists of Rahway, New Jersey.

Roger Adams, head of the Chemistry Department, University of Illinois, and chairman of the American Chemical Society's Board of Directors, will be made honorary member of the American Institute of Chemists on January 13. The award will be made at a meeting of the Chicago chapter of the Institute, to be held at the Western Society of Engineers, Chicago.

George Sachs has resigned as director of the National Metallurgical Laboratory, Jamshedpur, India, and has established offices as consulting engineer in Cleveland. Dr. Sachs has been appointed president of the newly established Metals Research Associates, Inc., Cleveland. He will also act as consultant to the National Advisory Committee for Aeronautics.

The 80th birthday of **Wesley R. Coe,** professor emeritus of biology at Yale University, and visiting research associate at the Scripps Institution of Oceanography, was celebrated on November 11 at a dinner given by the faculty of the institution. Professor Coe was presented with a volume of complimentary letters from colleagues, fellow biologists, and former students.

William W. Rubey, staff research geologist of the U. S. Geological Survey, has been elected president of the Geological Society of America to serve during 1950.

Howard T. Evans, former head of the X-ray Diffraction Division of the Massachusetts Institute of Technology's Insulation Research Laboratory, has joined the staff of the Philips Laboratories, Irvington-on-Hudson, New York, for work on the application of x-ray crystallography to the study of the physics of solids.

Peter Bernfeld, formerly of the University of Geneva, has been appointed assistant professor of biochemistry at Tufts College Medical School. He will carry out enzymological research in the laboratories of the Cancer Research and Cancer Control Unit.

Visitors

Investigators working in the laboratories of the Department of Zoology, University of Chicago, include **P. Ferreira-Berrutti,** of the University of Montevideo (a Rockefeller Fellow); **Gert Andres,** of the University of Bern (Fellowship under the American Cancer Society); **Fiametta Rossetti,** of the University of Rome (Fellowship under Public Health Service Grant).

Grants and Awards

AAAS Research Grants have been awarded by the Washington Academy of Science to: *Edward C. Raney,* associate professor of zoology and fishery biology, Cornell University, $150 for assistance in a study on the distribution of the fishes of Virginia; *Angus M. Griffin* and *Jeanne C. Moan,* Department of Bacteriology, School of Medicine, George Washington University, $250 for assistance in completing a study on induced variations in the group of coliform organisms.

The British Royal Society has awarded two **Royal Medals** for 1949: to George Thomson, for his contributions to many branches of atomic physics, and especially for his work in establishing the wave properties of the electron; and to R. A. Peters, for his biochemical researches, in particular his investigations of the biochemical role of vitamin B_1 in tissue metabolism and of the toxic action of lewisite and other arsenical compounds. The Royal Society also awarded the **Copley Medal** to G. C. de Hevesy, for his work on the chemistry of radioactive elements and especially for his development of radioactive tracers; the **Davy Medal** to A. R. Todd, for his structural and synthetic studies in organic and biochemistry, with special reference to vitamins B_1 and E and the naturally occurring nucleosides; the **Sylvester Medal** to L. J. Mordell, for his researches in pure mathematics, especially for discoveries in the theory of numbers; and the **Hughes Medal** to C. F. Powell, for his work on the photography of particle tracks in connection with the discovery of mesons and their transformation.

The National Cancer Institute recently awarded $2,174,900 to 14 hospitals, universities, and other institutions for construction of cancer research facilities. The new awards are as follows: Boston University, $49,900; Duke University, $200,000; George Washington University, $250,000; Loyola University's Stritch School of Medicine, $200,000; Ohio State University, $300,000; Oklahoma Medical Research Foundation, $125,000; University of Pittsburgh, $200,000; University of Southern California, $200,000; Stanford University, $100,000; the M. D. Anderson Hospital for Cancer Research, University of Texas, $100,000; Wayne University College of Medicine and Detroit Institute of Cancer Research, jointly, $150,000; Western Reserve University and the University Hospitals of Cleveland, jointly $300,000.

The Gorgas Award for 1949 was presented to H. Trendley Dean, director of the National Institute of Dental Research, U. S. Public Health Service, at a meeting last month of the Association of Military Surgeons of the U. S. Dr. Dean received the award for his demonstration of the relation of fluoride-bearing waters to dental health.

New York University-Bellevue Medical Center has received two separate gifts totaling $550,000: one of $450,000 from Bernard M. Baruch; the other $100,000 from the Louis J. and Mary E. Horowitz Foundation. The two gifts will be applied to the construction of that section of the Medical Center which will house the Institute of Physical Medicine and Rehabilitation in its new permanent home.

Harald H. Nielsen, chairman of the Department of Physics and Astronomy at Ohio State University, has been awarded the **Medal of the University of Liège** in recognition of his personal achievements in the field of infrared spectroscopy and his leadership of the Physics Department at Ohio State. Dr. Nielsen is on leave of absence while studying and working in Europe under a Guggenheim Fellowship.

Fellowships, Scholarships, and Prizes

The National Science Fund will award, on behalf of the **Sugar Research Foundation,** a prize of $25,000 for the most significant discovery in the utilization of sugar made during the past five years. Applications must be submitted by *February 1,* and the prize will be awarded March 15. Additional information may be obtained from the National Science Fund of the National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D. C.

Availability of the Damon Runyon Clinical Research Fellowships has been announced by the American Cancer Society. In most cases a fellowship will provide a period of training in a hospital under the guidance of a qualified clinical investigator, but it may be awarded for training in a basic science provided that such training is directed toward preparing the fellow for clinical cancer research. Fellowships are administered by the society upon recommendation of the Committee on Growth of the National Research Council. Applications submitted prior to *March 1, 1950* will be acted upon during April. Communications should be addressed to the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

The Edwards A. Deeds Fellowship for research in physical science (engineering, metallurgy, chemistry, physics, mathematical physics, or any related subject) is being offered by the University College, Dundee, within the University of St. Andrews. The fellowship, open to both men and women, is of the value of £750 to £1050 per annum and is tenable for three years. The fellow will have the status of a university lecturer and, as part of his duties, may do a limited amount of advanced teaching in his department. Applications should be sent to Patrick Cumming, Secretary, University College, Dundee, Scotland, not later than *March 31, 1950.*

Colleges and Universities

The Botany Department of the **University of California at Berkeley** has received an endowment fund of $320,000 from the estate of the late Willis Linn Jepson, professor emeritus of botany. The will stipulates that the fund be used for care and maintenance of the Jepson herbarium and library, the completion of the *Flora of California,* the revision of the *Manual of the flowering plants of California,* and the furtherance of studies on the flowering plants of the state and adjacent areas.

A new course, "Introduction to Oceanography," has been added to the graduate curriculum in biological oceanography, recently introduced by the **Narragansett Marine Laboratory of Rhode Island State College** with the cooperation of the Woods Hole Oceanographic Institution. Lecturers include Columbus O'D. Iselin, Woods Hole director, and Charles J. Fish, Narragansett director.

The Johns Hopkins University has accepted responsibility for operation of the scientific research and administration of the Arctic Research Laboratory at Point Barrow, Alaska, under a contract with the Office of Naval Research. George E. MacGinitie has been appointed resident director of the laboratory to coordinate the research at Point Barrow. Prof. MacGinitie is on leave of absence from the California Institute of Technology. The work at the Arctic Laboratory will be entirely handled by university scientists and their work will be unclassified. The laboratory was established in August 1947 as a frontier arctic field station for basic scientific research of physical and biological phenomena never before studied in arctic environment.

Meetings and Elections

The National Research Council's new Building Research Advisory Board will hold its first research correlation conference January 11–12 in Washington, D. C. The conference, entitled "Weather and the Building Industry," will consider the climatological research and its effect on building design, construction, materials, and equipment. Francis W. Reichelderfer, chief of the U. S. Weather Bureau, and Paul Siple and Helmut Landsberg, of the National Military Establishment, will take part in the conference. Those wishing to attend should communicate with William H. Scheick, executive director of the Building Research Advisory Board, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

The Sixth Annual Conference on Protein Metabolism, sponsored by the Bureau of Biological Research at Rutgers University, New Brunswick, New Jersey, will be held January 27–28. Biosynthesis of the purines, effects of protein depletion on enzymes, transaminases and related enzymes in amino acid synthesis, alternative metabolic pathways leading to cancer, rates of plasma protein formation in man, and intravenous therapy in man will be discussed respectively by John M. Buchanan, University of Pennsylvania; Earl P. Benditt, University of Chicago; Irwin C. Gunsalus, Indiana University; Van R. Potter, University of Wisconsin; Irving M. London, Columbia University; and Charles S. Davidson, Boston City Hospital. The conference is open to all interested persons who register. Inquiries should be addressed to William H. Cole, Rutgers University, New Brunswick, New Jersey.

The third annual symposium on modern methods of analytical chemistry, sponsored by the College of Chemistry and Physics, Louisiana State University, will be held January 30–February 2 on the university campus. Further information may be obtained from Philip W. West, Department of Chemistry, Louisiana State University, Baton Rouge, Louisiana.

The American Society for Horticultural Science elected the following officers for the year 1949–50: president, S. L. Emsweller, Plant Industry Station, Beltsville, Maryland; vice president, A. F. Yeager, University of New Hampshire, Durham; secretary-treasurer, Freeman S. Howlett, Ohio Agricultural Experiment Station, Wooster. H. B. Tukey, editor of the *Proceedings* since 1928, offered his resignation effective January 1.

Raymond F. Guy, manager of radio and allocations engineering of the National Broadcasting Company, has been elected president of the **Institute of Radio Engineers** for 1950. He will succeed Stuart L. Bailey, of Washington, D. C. on January 1. Sir Robert Watson-Watt, British radar authority, has been elected vice president.

The American Society of Professional Biologists, Inc., recently announced the election of the following officers: president, Roy F. Fritz, Department of Public Health, Berkeley, California; president-elect, Archie D. Hess, U. S. Public Health Service, Savannah, Georgia; treasurer, Alfred A. Draper, director of Steffan Laboratories, New York City; vice presidents, William Levin, director, Oregon Hygienic Laboratory, Portland, Oregon; H. Orin Halvorson, head, Department of Bacteriology, University of Illinois; Martin D. Young, U. S. Public Health Service, Columbia, South Carolina; Robert M. Johnston, director, Johnston Laboratories, Harrisburg, Pennsylvania; executive secretary, Norman C. Laffer, associate professor of bacteriology, University of Maryland.

Recently Received—

Nuclear Science Abstracts, U. S. Atomic Energy Commission. Vol. 3, No. 5. Technical Information Branch, Oak Ridge. 25¢.

1948 Annual Report of the John and Mary Markle Foundation. John and Mary Markle Foundation, 14 Wall Street, New York City.

Goethe and Pharmacy. George Urdang. American Institute of the History of Pharmacy, Madison.

A Half Century of Globular Clusters. Harlow Shapley. Harvard reprint 320. Harvard Observatory, Cambridge, Massachusetts.

The Society for Clinical and Experimental Hypnosis, 26 West 9th Street, New York City, is organizing a reprint library and would appreciate receiving two reprints each of any article dealing with hypnosis. Reprints may be forwarded to the society, attention of Jerome M. Schneck, chairman.

Mental Hospital Service, the clearinghouse soon to be established by the American Psychiatric Association to serve mental hospitals and other institutions caring for psychiatric patients in the U. S. and Canada, will have its headquarters in Washington, D. C., under the direction of Daniel Blain, medical director of APA. A grant from the Commonwealth Fund of $45,000 made the project possible, but it is expected that it will eventually be self-supporting through subscription fees from participants.

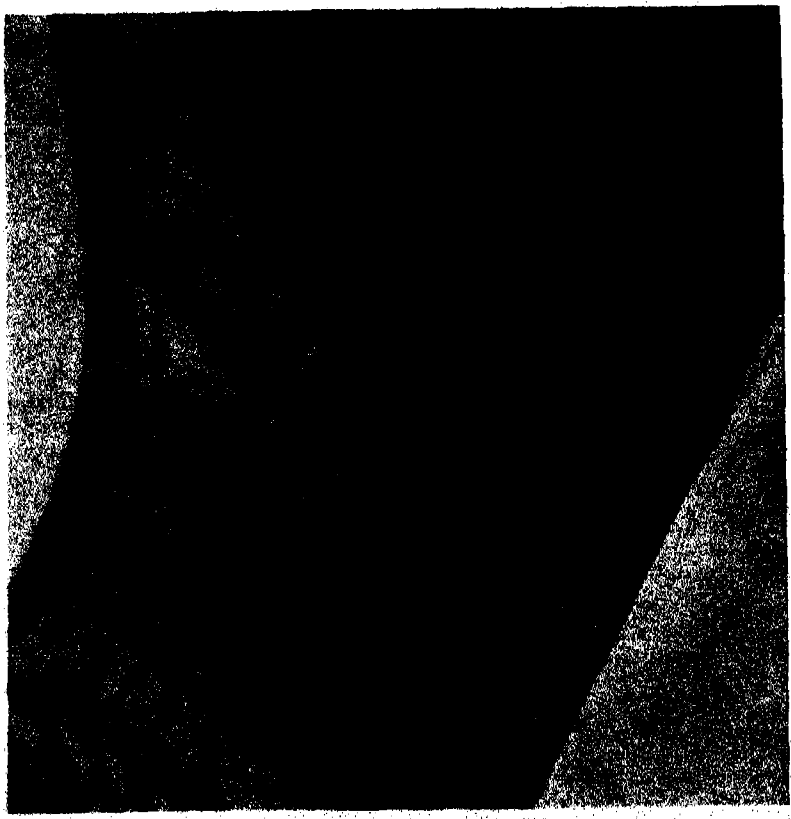
The U. S. National Committee on Theoretical and Applied Mechanics, recently formed by seven national scientific and engineering societies, has been admitted as an adhering body to the International Union of Theoretical and Applied Mechanics. Member organizations of the committee are the Society for Experimental Stress Analysis, American Society of Civil Engineers, American Institute of Chemical Engineers, Fluid Dynamics section of the American Physical Society, Institute for Aeronautical Sciences, American Mathematical Society, and the American Society of Mechanical Engineers. Future plans call for American representation at a collegium on geophysics in 1950, and at a meeting of the IUTAM in Rome. Plans are now under way for an international congress for theoretical and applied mechanics to be held in the U. S. during 1951.

The reactor development program of the Atomic Energy Commission was the major subject under discussion at a press conference November 28—the first of an announced series of such conferences, to be held about once a month for the purpose of removing some of the secrecy surrounding atomic energy. Chairman David E. Lilienthal, whose resignation from the AEC will be effective December 31, presided.

A "breeder" reactor, using fast neutrons to convert the nonexplosive and naturally occurring uranium 238 to fissionable plutonium, has been designed at Argonne National Laboratory, it was announced, and will be built next year at the commission's new nuclear reactor testing station near Arco, Idaho. The theoretical possibility of a pile that produces more fuel than it consumes was announced by the AEC two years ago. Now engineering work is more than 90 percent completed and the reactor will be tested about 18 months hence. Dr. Lawrence Hafstad, director of the reactor program, called the project "the biggest . . . peacetime development in atomic energy that has been made."

Another breeder is being developed to produce significant amounts of electric power, using neutrons in the intermediate energy range. Construction is expected to begin at the site of the Knolls Atomic Power Laboratory early next year. If successful, the Knolls reactor will point the way toward production of useful power without depleting the national supply of fissionable material.

The commissioners said they expected that by 1952 the AEC would be building an atomic engine for ship propulsion. They also announced the design of an experimental reactor to provide information on the behavior of materials under severe radiation conditions. This is of particular interest in the development of reactors for the propulsion of aircraft.



A RECENTLY DEVELOPED TECHNIQUE for producing very thin slices of solid layered material made possible this transmission electron micrograph of a splitting of synthetic fluorine-phlogopite mica, showing laminar morphology of the mica. The dark bands are believed to be electron optical effects. Althea Revere, associate professor of electron microscopy at Stevens Institute of Technology, Hoboken, New Jersey, developed the technique and prepared the micrograph. Magnification 10,000 x with resolution.

Statement of the National Academy of Sciences on the AEC Fellowship Program

The provision for loyalty and security investigation of all Atomic Energy Commission fellows, included in a rider to the 1950 Independent Offices Appropriation Act passed by Congress last August, has far-reaching implications for scientists and scientific freedom. It posed an immediate problem to the National Academy of Sciences: whether or not its National Research Council should continue to administer the AEC fellowship program under the new restrictions. A quasi-governmental body, the NRC accepts an obligation to give any advice it can to a government agency that asks it. But discussions within the Academy and the NRC revealed almost unanimous opposition to the application of clearance procedures to fellows working in nonsecret areas.

When the AEC asked for advice on the future direction of its fellowship program the Academy replied:

> *We are convinced that by this restriction the value of the broad program has been greatly reduced; we have grave doubts whether [its] continuance . . . thus restricted is in the national interests. . . .*
>
> *Since we hold these views, we believe that the National Research Council should not accept the responsibility for administering the altered fellowship program.*
>
> *We hope that, to the extent to which the Atomic Energy Commission continues the program, it will find it possible to administer it without our help. Nevertheless, in the measure in which our advice in one form or another may prove necessary to the Commission, we recognize an obligation to provide such advice.*
>
> *We would further urge the Atomic Energy Commission to take all proper steps to see that these restrictive provisions be omitted from future legislation. We in turn shall make known to the Government of the United States the reasons for the views here expressed.*

The AEC considered and rejected this suggestion that it should take over administration of the program, stating as its reasons:

> *1. The AEC believes any fellowship program affecting a substantial number of students training in broad and established fields of science should be administered by a scientific or educational organization. While an executive agency of the Government may properly sponsor such a program, it should not administer it.*
>
> *2. The National Academy of Sciences, the senior agency for cooperation between the Government and the scientific community, has gone on record as opposing FBI investigation of fellows appointed to nonsecret work. It would be extremely difficult to administer an effective fellowship program that did not have the full support of the scientific community.*

Further consultation and correspondence between officials of the Academy and those of the AEC led to agreement on a contract for NRC administration of a fellowship program for 1950–51 revised to meet the new conditions. No new predoctoral fellowships will be offered for 1950–51. Postdoctoral fellowships will be limited to work requiring secret information. To fulfill prior commitments, applications for renewal of current nonsecret predoctoral fellowships and postdoctoral medical fellowships will be accepted, subject to the clearance provisions. It is expected that about 75 new awards will be offered and about 175 renewals granted. There are now 421 AEC fellows, 30 engaged in secret work and 391 in nonsecret work.

The statement by the National Academy of Sciences is reproduced here, together with related correspondence between the Academy and the AEC.

IN AUGUST 1949, the Congress passed an amendment to the Independent Offices Appropriation Act of 1950 which requires that holders of Atomic Energy Commission fellowships must be given clearance from the AEC after having been investigated as to character, associations, and loyalty by the Federal Bureau of Investigation. On the basis of the record of the hearings before the Joint Congressional Committee, this enactment is believed to carry the implication that the fellowship program is designed to provide the nation with scientists who are not only trained to utilize knowledge of nuclear energy and fissionable materials in their study of problems in physics, biology, medicine, etc., but who also would be available for work associated with the classified activities of the AEC.

To explore means for meeting this implication and at the same time discharging its statutory obligation to render assistance within its competence to any government agency requesting it, the National Academy of Sciences held discussions within its council and membership and its officials met with those of the AEC. To carry out the decisions thus reached, the Academy has agreed to enter into a contract proposed by the AEC, under the terms of which the NRC will administer during 1950–51 a new program of fellowships, limited in scope and differing in character from that previously in force.

Commitments for renewals for 1950–51 of fellowships awarded for 1949–50, as published in previous NRC announcements, will be fulfilled, subject, however, to the provisions of the new law.

The revised fellowship program was developed after the AEC had been informed of the opinions of the council of the Academy regarding the influence of the new restrictions and of its members' convictions concerning the responsibilities of the Academy to American science, as well as to the Government of the United States. It is described in the following letter.

Letter dated December 9 from Carroll L. Wilson, general manager of the U. S. Atomic Energy Commission, to Alfred N. Richards, president of the National Academy of Sciences:

"The Commission has carefully considered the conditions set forth in your letter of November 30 under which the National Academy is willing to authorize the National Research Council to administer a new and more limited Atomic Energy Commission Fellowship Program. The Commission plans to explore further the desirability of sponsoring in some way a predoctoral fellowship program in fields relating to atomic energy. It intends, of course, to seek the advice of the Academy on this question. In the meantime the Atomic Energy Commission requests the National Academy of Sciences to authorize the National Research Council to administer a program of Atomic Energy Commission fellowships in accordance with the following conditions:

"1. Predoctoral fellowships will not be offered by the National Research Council for the academic year 1950–51.

"2. In order that commitments in announcements of the predoctoral fellowships and of the postdoctoral medical fellowships for 1949–50 shall be fulfilled, applications for renewal of current fellowships in these categories will be solicited by the National Research Council and renewal recommended for those whose progress warrants it. However, because of the amendment to the Independent Offices Appropriation Act of 1950, such recommendations can become effective only after the applicant has been investigated as to character, associations and loyalty by the Federal Bureau of Investigation and clearance given by the Atomic Energy Commission. Hence those whose applications for renewal are approved by the National Research Council will receive from the Atomic Energy Commission a copy of the amendment referred to above and a personnel security questionnaire which must be filled out and returned before the FBI investigation can be initiated. Decisions by AEC, based upon the FBI report, will determine the fellowship awards.

"3. The National Research Council will administer a limited program of postdoctoral fellowships in the physical sciences, biology, biophysics and medicine for advanced training in fields of secret work or in problems which require access to restricted data. For holders of these fellowships, FBI investigation and full security clearance constitute an accepted requirement.

"In the physical sciences, the fields of study will be limited to those closely related to the Atomic Energy Commission program, such as the chemistry and nuclear physics of elements of atomic number 90 and above, the neutron physics of the elements, the effect of high energy radiation on matter, the chemistry of elements in the fission product range, and the separation of isotopes.

"In biology, biophysics, and medicine, the research fields will include experimental aspects related to atomic energy which require the use of the special facilities available in the AEC installations and/or access to restricted data. This work would include studies such as the physiological and toxicological effects of fission products, and the development of radiation instruments as applied to biological and health physics problems of a classified nature.

"4. The administrative commitments set forth in this letter do not extend beyond June 30, 1951.

"We understand from your letter of November 30, 1949 that the National Academy of Sciences agrees to the provisions enumerated above. Members of the staff of the Commission will arrange with the National Research Council for the implementation of this fellowship program and for public announcement of the revised program."

The correspondence that led up to Mr. Wilson's letter of December 9 follows.

Letter dated September 27 from Carroll L. Wilson, general manager of the U. S. Atomic Energy Commission, to A. N. Richards, president of the National Academy of Sciences:

On August 18, 1949, Mr. Carleton Shugg, Deputy General Manager, wrote to you calling attention to the provision of the Independent Offices Appropriation Act which concerns fellowships. At that time the immediate legal obligations particularly in relation to the renewal of present fellowships were emphasized. At this time it seems appropriate to initiate a general consideration of the future scope and character of the fellowship program. The recommendations of the National Academy of Sciences and the National Research Council in these matters will be welcomed.

Letter dated November 2 from Alfred N. Richards, president of the National Academy of Sciences, to Carroll L. Wilson, general manager of the U. S. Atomic Energy Commission:

In your letter of 27 September 1949, addressed to the National Academy of Sciences, you have stated that recommendations of the National Academy of Sciences and the National Research Council concerning future scope and character of the Atomic Energy Commission fellowship program would be welcomed. The question has accordingly been made the subject of lengthy discussion by the Council of the Academy, the opinions of the entire membership of the Academy have been solicited, and at two business sessions of the Academy at its meeting in Rochester, October 24–26, the question was thoroughly debated and the sense of the meeting ascertained. The attached statement was drawn up by the Council of the Academy and submitted for discussion to those members of the Academy who attended the autumn meeting. It may be regarded as representing the opinion of the Council and of a large majority of the members who have had the opportunity of discussing it.

It might clarify your understanding of the second part of the second sentence of the second paragraph if I tell you that the wording of that sentence is a last-minute change made at an informal meeting of the Council from a sentence which read as follows: "We have grave doubts whether a program thus restricted is more in the national interest than no such broad AEC fellowship program at all."

The part of the statement entitled "Annex" is to be regarded as an appendix which might be made the subject of discussion with you.

STATEMENT CONCERNING THE AEC FELLOWSHIP PROGRAM PREPARED BY THE COUNCIL OF THE NATIONAL ACADEMY OF SCIENCES AND SUBMITTED BY ITS PRESIDENT

The Council of the National Academy of Sciences has considered the request of the Atomic Energy Commission for advice as to the scope and future of the fellowship program, in the light of the restriction placed upon it by the amendment to the Independent Offices Appropriation Act of 1950.

In our opinion the requirement of FBI investigation and Atomic Energy Commission clearance is ill-advised for those fellows who neither work on secret material, nor are directly preparing for work on Atomic Energy Commission projects. We are convinced that by this restriction the value of the broad program has been greatly reduced; we have grave doubts whether the continuance of the Atomic Energy Commission Fellowship Program thus restricted is in the national interests. In these views we concur with the opinion expressed by the Executive Board of the National Research Council.

Since we hold these views, we believe that the National Research Council should not accept the responsibility for administering the altered fellowship program.

We hope that, to the extent to which the Atomic Energy Commission continues the program, it will find it possible to administer it without our help. Nevertheless, in the measure in which our advice in one form or another may prove necessary to the Commission, we recognize an *obligation to provide such advice.*

We would further urge the Atomic Energy Commission to take all proper steps to see that these restrictive provisions be omitted from future legislation. We in turn shall make known to the Government of the United States the reasons for the views here expressed.

ANNEX

1. We hope the Atomic Energy Commission will itself operate this program.
2. We regard it as a proper function to advise on setting up Atomic Energy Commission panels to select fellows.
3. If it is not possible for the Atomic Energy Commission to set up panels, the National Research Council will upon request make an assessment of the qualifications of the fellows and a report on the progress of their work.
4. Announcements should be made by the Atomic Energy Commission and the extent of the participation if any of the National Research Council should be made clear.
5. In announcing the fellowships we believe it the duty of the Atomic Energy Commission to see that the prospective fellows are told the nature of FBI investigation and the criteria by which decisions are to be made by the Atomic Energy Commission.
6. Our special misgivings about FBI investigation and Atomic Energy Commission clearance do not apply to candidates for secret work.

October 26, 1949

Letter dated November 17 from Carroll L. Wilson, general manager of the U. S. Atomic Energy Commission, to Alfred N. Richards, president of the National Academy of Sciences:

We have considered your letter of November 2, 1949, and its attached statement prepared by the Council of the National Academy of Sciences. We understand that the Academy does not believe that the National Research Council should accept the responsibility for administering the Atomic Energy Commission fellowship program as altered by the amendment to the Independent Offices Appropriation Act of 1950. We regret that the restrictions imposed by the fellowship rider have made it necessary for the National Academy of Sciences to come to that conclusion. We feel, and we know you must also feel, that fairness to prospective fellowship applicants demands a statement in the near future of the status of the fellowship program. We are therefore writing to inquire if it would be acceptable to the National Academy of Sciences to have the National Research Council administer a *fellowship program limited, during the period the restrictions* of the amendment apply, by the conditions listed below.

1. No new appointments are to be made to predoctoral fellowships, except possibly for a small number of fellowships in secret fields.

2. The present broad program of postdoctoral fellowships is to be limited to those candidates whose proposed research is such that, in the opinion of the Commission, a high probability exists of subsequent employment requiring access to secret data. Fellows would not be obligated, however, to accept subsequent employment by the Commission or one of its contractors. We would expect this limitation to confine postdoctoral fellowships in the physical sciences to fewer fields than are now open. The present program of postdoctoral fellowships in the bio-

(Continued on page 670)

Growth Failure in School Children as Associated with Vitamin B_{12} Deficiency—Response to Oral Therapy

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DESPITE ITS ORIGINAL PROPERTY as a growth-promoting agent for certain bacteria (*4*) and subsequent evidence that it stimulates animal growth (*1, 2*), studies of vitamin B_{12} in man have been confined to its hematopoietic, clinical, and neurological effects in disease—viz., pernicious anemia and sprue. Information on its more general nutritional value has thus far had to come from animal work, in which growth could be experimentally held in check as desired, through purified diets, and thus through deprivation of B_{12} or of other food constituents, with or without caloric restriction. Since deliberate depletion in children is excluded, the growth effects of B_{12} must be studied under constraints which parallel those in anemia, in the sense that results must be appraised, not under normal blood or growth conditions, but in states of hematopathology and of growth failure, respectively. In the case of growth disturbance, however, the constraints are even more rigid, for, although it is permissible to follow B_{12} hematopoiesis in "untreated" or in "recently untreated" patients—that is, essentially under initial conditions of depletion—it happens that any one of a number of nonspecific agents, even mere environmental change, can set recovery from growth failure in motion. What this means is that a growth stimulus attributable to vitamin B_{12} must be demonstrated in the face of whatever recovery had already set in, and hence by potentiation of such prior effects, which had themselves, moreover, been sufficiently stable to be taking place under a condition of statistical control. Technically, the problem is one of "improving an improvement" and of measuring both.

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[1] With the technical assistance of Dr. Francis Bayless, Edna Chapman, and Barney Tautkins.

Certain other aspects should be considered in order to clarify interpretations. Onset of simple growth failure in school age children, as evaluated by the Grid technique (*5*), is characterized by quite specific deviations beyond known tolerance values for two chief parameters, the *direction* (Fig. 1-A) and the *speed* of physical development (B), with associated deviations in body *size* (level) and *shape* (physique channel) and with the consequent accumulation of corresponding caloric "fuel debts" (*6*). Recovery, on the other hand, is measured by reversal of such trends and, in particular, by the extent to which physique is restored, lag made up, and fuel debt repaid.

For practical purposes, the chief tolerance values in healthy growth may be taken as follows: no child should lose more than ½ channel of physique in 10 levels of advancement and it should not fail by more than 2 or 3 levels to attain its expected year-end level position if it is to develop at the normal rate of 1 level per month or 12 levels per year. These parameters and tolerances, it may be emphasized, are independent of race, sex, weight, height, size, shape, and—up to maturation—of age.

As a rule, recovery from and treatment of simple growth failure in school children, whether mild, moderate, or severe as regards physique loss, level lag, or calorie debt, is readily achieved through systematic programming designed to meet individual needs (*6*). Some of the prominent elements of such programs are good hygiene, balance between exercise and rest, planned calorie conservation, and emotional calm, all aimed at restoring physique to par, and eliminating lag and fuel debts. The affliction is peculiarly amenable to group or institutional management when individual personality problems can be worked out. Obviously, diets must supply all daily needs including overages to cover fuel debts (*6*); composition approximates carbohydrates 50 percent, fats 35 percent, and proteins 15 percent. On occasion, vitamin supplements are required. Nutrition is clearly to be emphasized because it is always involved in recovery, regardless of the main or inciting cause or causes that led to growth failure.

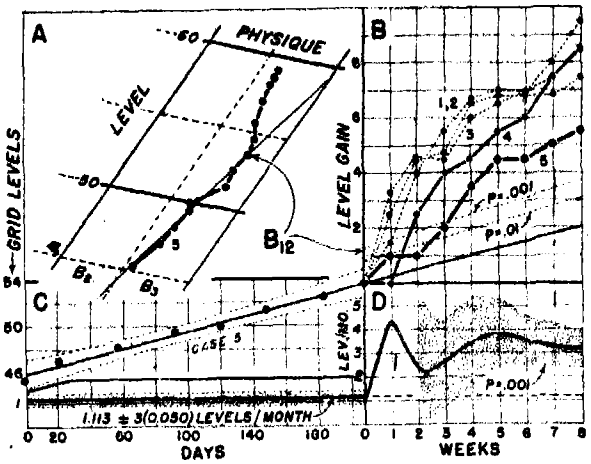

FIG. 1. Growth responses to oral vitamin B_{12}. A—Directional shift with increasing physique in Case 5. B—Level gains in five reactors with confidence bands for No. 5. C—The previous 208-day regression of Grid level on time with its 0.001 confidence band; data show existence of Shewhart (*3*) state of control. Lower C—Rate of development for No. 5, with standard error and error band. D—Velocity surge in No. 5 following administration of B_{12} and the 0.001 confidence band.

We have repeatedly observed beneficial effects from vitamin supplements or from oral administration of whole liver extract[2] which are specially prescribed when progress has been delayed out of proportion to physical or other findings. On the other hand, we have been impressed with unaccountably slow progress in spite of intensive effort to seek out causes and to establish more satisfactory recovery rates. At such times, the possibility of unknown and otherwise unheralded deficiencies has naturally suggested itself.

In August 1949 we began to administer 10 µg of crystalline vitamin B_{12} orally[3] to 11 children (6 boys, 5 girls; ages 5–12 years) 3 of whom (Nos. 2, 4, 5 of Fig. 1) were selected on account of slow progress, the remaining 8 at random from a group of 76 under regular care for varying degrees of malnutrition and in varying states of recovery from simple growth failure. Oral administration of the same dose was continued daily at the time of the usual midmorning milk offering. Heights and weights (clothes off) were remeasured weekly at the same hour. All other program elements were strictly maintained as before on an individual basis. A child, for example, who had been getting extra rest, or another who had been receiving whole liver extract, continued to do so.

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[2] First suggested to us by Paul György in 1941.

[3] Crystalline vitamin B_{12} (Cobione®) was kindly supplied by the Medical Division of Merck & Company, Inc. of Rahway, New Jersey.

TABLE 1

RATES OF DEVELOPMENT, STANDARD ERRORS, ETC.

Case No.	Levels per month			Degrees of freedom	t	p
	Before	After	Difference*			<
1	2.50 ± 0.40	5.30 ± 0.42	2.80 ± 0.56	9	5.00	0.001
2	0.65 ± 0.12	3.40 ± 0.66	2.74 ± 0.63	15	4.35	0.001
3	0.65 ± 0.88	4.52 ± 0.60	3.87 ± 0.68	7	5.66	0.001
4	1.89 ± 0.62	4.71 ± 0.31	2.81 ± 0.69	10	4.09	0.01
5	1.113 ± 0.050	3.18 ± 0.25	2.06 ± 0.23	13	8.96	0.001
65 Controls	2.27 ± 0.13	....	....	317	...	....
6 Nonreactors	1.86 ± 0.12	2.00 ± 0.70	0.00	...	...	....

* Errors of differences computed from pooled variances.

Five of the original 11 subjects responded dramatically to this single change in routine represented by the administration of B_{12}, the effects being objectively measured by physique and level gains as charted on each child's Grid record and, for utmost accuracy, as calculated from the corresponding equations for physique, *P*, and level of development, *D* (*5*). Before and after values of regression coefficients, standard errors thereof, and confidence bands for values of $p = 0.01$ and 0.001 were likewise computed, with due allowance for degrees of freedom available from the number of previous observations. Untreated resident children were a time-place-season control group.

Results summarized in Table 1 and in Fig. 1-B show that 4 of the 5 reactors achieved an average gain of more than 8 levels in 8 weeks, and thus somewhat more than the response of Case 5 who, though gaining only 5½ levels in the same interval, nevertheless exceeded her own 8th week expectancy (as estimated from the extension [B] of the regression [C]) by 3.6 levels, so that $t = 12.3$ and p is considerably less than 0.001 for the 6 degrees of freedom contributed by the previous 208-day control period in C. The response of Case 5 is further defined in Fig. 1-A, -C, and -D. In particular, her course of development in 1-A, which had been deviating by more than ½ channel per 10 levels advance, shifted promptly in the direction of increasing physique; in upper 1-C are the linear regression of level on age (time) and the confidence bands for $p = 0.001$; in lower 1-C, the corresponding constant rate of development, 1.113 ± 0.050 levels per month, with its associated error band of $3\sigma_b$. The statistical evidence of 1-C illustrates the attainment of Shewhart (*3*) conditions of control prior to administration of vitamin B_{12}. Finally, in section Fig. 1-D is shown the pulselike surge in the speed of development corresponding to the level gains of Case 5 in 1-B, along with the 0.001 confidence band based on the degrees of freedom available at successive weekly observations. From Fig. 1-B and -D the effect of B_{12} had become statistically significant at the $p = 0.01$ level by the end of the third week, and at the $p = 0.001$ value by the fourth week.

Clinical examinations prior to B_{12} ingestion revealed no characteristic or even suggestive regional signs in hair, skin, eyes, mouth, or nervous system. The only noticeable clinical changes after B_{12} administration were those of increased physical vigor, alertness, better general behavior, but above all, a definite increase in appetite, manifested by demands for "second helpings," as contrasted with comparatively indolent food habits before. Moderate eosinophilia (6–8 percent) and reticulocytosis (0.6–0.9 percent) were found in 9 of the 11 subjects.

The most dramatic general effects were shown by Case 2, a boy with severe allergic bronchitis, whose sleep for 12 months before had been regularly interrupted by asthmatic attacks and whose daytime wheezing permitted little desire for food, not to mention time for eating it. His growth response was accompanied by a remarkable attenuation of symptoms; in fact, these simply vanished during the first week, to the surprise of every attendant, lay or professional. What possible connections there may be between B_{12}, its influence on protein metabolism, and allergic disturbance, are questions for further investigation.

Taken together, the foregoing results speak, and they speak with measurable statistical certainty, of what may be termed B_{12} functional deficiency, that was definitely benefited by oral therapy. As a final measure of effects it may be remarked that the growth responses were equivalent to another 100–240 days of regular institutional care without the help of B_{12}.

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Technical Papers

Atom Bomb Cataracts[1]

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At the suggestion of the Committee on Ophthalmology of the National Research Council, a survey has been undertaken to determine what, if any, late ocular effects have resulted from the atom bombings in Japan. The undertaking was prompted in considerable measure by the recent discovery of cataracts in cyclotron workers. The survey is being currently carried out under the auspices of the Atomic Bomb Casualty Commission, and the present communication is a preliminary report on ten cases of cataracts which are believed to have been caused by the atomic bombs.

Nine of the patients were exposed at Hiroshima and one of the patients at Nagasaki. All were said to have had normal visual acuity prior to the bombing and for some time afterward. Seven were males and three were females. The ages at the time of the exposure were 13 to 55 years. All were within 550 to 950 meters of the hypocenter at the time of the explosion. Three were standing in the forward part of a streetcar next to each other, four were in wooden houses roofed with tile, one was crouching behind a wooden building, one was walking in the street, shielded by the plaster wall of a building, and one is not known to have had any shielding. Two had thermal burns of the profile type (that is, due to radiant heat); all had epilation of the head after a latent period of one to four weeks, with complete baldness lasting three to seven months. Six vomited on the day of the explosion, and eight had symptoms one to three weeks after the explosion consisting of fever and malaise, with vomiting and diarrhea in five and petechiae in five. One developed a sloughing lesion of the buccal mucosa and another a localized necrosis of the cheek with perforation. Whether these were due to radiation sickness or to the insanitary conditions prevailing at the time could not be determined. One of the three female patients has had amenorrhea since the exposure and the other two began their menses at ages 17 and 19, approximately three years after the exposure.

The only ocular complaint of the patients was failing vision. In one patient, the onset of subjective visual symptoms was said to have been as early as one month after the bombing, but the patient was in an apprehensive mental state at the time and it is by no means certain that this initial complaint was owing to incipient cataracts. The latent period of visual symptoms was 6 months in one patient, 2¼ years in one patient, and 2½ years in four patients. Three patients had no ocular complaints. The failure of vision was said to have been either gradual or stepwise and fluctuant in the seven patients, one of these patients having thought some improvement followed each loss. Three of the patients had been seen by Japanese ophthalmologists and recognized as having cataracts due to radiation: two by H. Ikui and one by K. Hirose.

The cataracts consisted of opacities in the axial zone of the posterior lenticular capsules over an area of 2 to 4 mm, with occasional punctate dots farther toward the periphery. The findings were approximately symmetrical in the two eyes. The central opaque disks had jagged but nevertheless relatively sharp edges. In the five patients in whom the changes were most marked, the peripheral portions of the opaque disks were denser than the central portions, forming doughnut-shaped opacities when examined with the ophthalmoscope. With the slit-lamp biomicroscope the opacities were of a lace-like texture, having a few polychromatic crystals and a few vacuoles. The opacities were confined to the posterior capsules, with no apparent extension into the underlying cortex, but the vacuoles were situated just in front of the capsules. In the two most advanced cases there was a distinct separation of the opacity centrally into two laminae from front to back, with a relatively clear interval between them. Toward the periphery of this central disk the two laminae fused to form the denser ring that had given rise to the doughnut-shaped opacities seen with the ophthalmoscope. In the less advanced cases, which did not show the doughnut configuration, the central portion showed an opacification of the whole thickness of the posterior capsule similar to the peripheral portion of the disk in the more advanced cases. Thus it appears that progression of these cataracts is accompanied by a separation of the central opacity by a clear interval and an extension of the unsplit opacity toward the periphery. The anterior capsule also showed a few punctate dots in seven of the patients and an occasional vacuole in three. The lens cortex and nucleus, however, was entirely clear in all cases.

The cataracts are considered to be similar to those which have previously been associated with exposure to x-rays and gamma rays (*1*). What part neutrons played in their pathogenesis is not evident. The patients were in a zone where neutrons and gamma rays were present, although information on the amounts of each is not accurately available. Most persons in this zone died either from thermal or mechanical injuries or from radiation sickness. That these persons survived and developed cataracts may be attributed simply to biologic variations; but it cannot be reasonably denied that whereas the cataracts resulted from exposure of the head region, the absence of lethal radiation disease may have been owing to a shielding of much of the rest of the body. Five of the patients had very little, if any, radiation sickness, and the symptoms in the others may not have been caused by the radiation. Yet all of them had profound epilation of the head, which was undoubtedly a radiation effect. It is possible that the three standing in front of the streetcar were protected in the lower halves of their bodies by the metallic baseboard below the car windows.

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[1] This work was sponsored by the Atomic Bomb Casualty Commission, National Research Council, with funds supplied by the U. S. Atomic Energy Commission.

The frequency of atom bomb cataracts now, or to be expected in the future, cannot be stated at present, since practically all the cases of cataracts here cited were discovered through highly selective methods. However, it may be noteworthy that 1000 persons, believed to be a cross section of the survivors, who were within two kilometers of the hypocenter and in the open (including 16 persons within one kilometer), were examined and no case of radiation cataract was found. (Although all these persons were out of doors at the time of the explosion, the amount of shielding by buildings, posts, other persons, etc. could not be satisfactorily determined.) Among an additional 231 persons within one kilometer of the hypocenter, who were either in the open or in wooden buildings at the time of the explosion, there were found five cases of radiation cataracts (included in the ten mentioned above).

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Cyclotron-induced Radiation Cataracts

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Although it is impossible now to make a complete or final report on the cyclotron-produced radiation cataracts, it seems desirable to publish a preliminary survey of the situation as it now appears. This survey should serve as another warning to research personnel and administrators in the field of high energy particles and it also should serve to indicate how large is the area of ignorance regarding radiation effects on higher organisms.

Early in December 1948 it became known that at least five nuclear physicists of average age 31 were afflicted with incipient cataracts. An *ad hoc* committee set up by the Division of Medical Sciences of the National Research Council arranged for questionnaires to be sent to all the high voltage laboratories of the country where comparable exposure risks might have been incurred, and a considerable body of preliminary data became available by this means.

Arrangements were made to bring together as many as possible of the afflicted men, along with a few other especially qualified and interested individuals, to discover and compare if possible the common denominators of their experience and to make careful comparable medical examinations. A meeting was held in Washington, D. C., January 16 and 17, 1949, under the auspices of the Division of Medical Sciences, National Research Council, with the support of the U. S. Atomic Energy Commission. On January 18, eleven of these men were examined at the Wilmer Ophthalmological Institute, Johns Hopkins School of Medicine, by Drs. Alan Woods, Jonas Friedenwald, and Algernon Reese, who concurred in the following findings:

1. Ten of these patients showed opacities in the lenses.

2. The patients fell into three general groups as follows:

Group A (*3 men*): All showed severe changes in the posterior cortex of the lens, consisting of thick saucer or disk-like opacities, together with slight subcapsular or anterior cortical haze. The capsule and nucleus of the lens were clear, and there was no other pathology found in these eyes (except postoperative changes in one individual). In all vision was reduced.

Group B (*4 men*): Slight to moderate changes in the posterior cortex of the lens. These changes consisted in whitish opacities with a definite tendency to saucer or disk-like formation, in the milder cases accompanied by a golden reflex and occasionally by slight iridescence. Again there was occasionally slight haze in the anterior cortex, and a few vacuoles. The media and capsules were clear, and there was no other pathology in the eyes. In these men, vision was either normal or only slightly reduced.

Group C (*3 men*): Minimal, insignificant, and doubtfully relevant changes. The findings consisted in a thin lacy opacity in the posterior cortex and occasional punctate dots, and capsular iridescence. The thin lacy opacity, when observed, lay in the posterior cortex with a suggestion of disk formation, which made it a little suspicious. There was, however, considerable doubt in the minds of all three examiners whether these slight changes were definitely pathological. There were no other changes observed in these eyes.

3. All the observed changes followed the same general pattern, showing different degrees of severity. Furthermore, this common picture conforms to the general picture of roentgen-ray and radium cataracts. In the absence of other recognized causes, and with the common denominator of exposure to cyclotron irradiation, it appears logical to attribute these lens opacities to this cause.

Table 1 summarizes the experience of these men.

The men are listed in the table in the order of severity of symptoms. The first three men have what can be termed a severe handicap. The next four are afflicted to a degree which does not at present interfere markedly with daily life. The remaining three have a minimal affliction which does not cause appreciable handicap. It was noted, however, that the severe cases did not fully develop until about three years after the radiation was received. Hence, some of the men may in the future show a more severe pathological condition arising from radiation already received. Since there has been no evidence of damage to the retina, it would appear that there is a good prognosis for successful surgical intervention in the severe cases. Indeed, in the interval between January and July 1949, cataracts were successfully removed from two of the individuals concerned. Thus, it

TABLE 1

Patient	Probable date of exposure	Estimated total exposure to neutrons (n-units)	Duration of exposure in weeks	Visual acuity			
				Uncorrected		Corrected	
				Left	Right	Left	Right
1	1944	135*	200	LP†	. . .	LP†	20/200
2	1943–44	80	25	. . .	. . .	20/100	5/200
3	1943–44	80	25	20/100+2	20/70–1	20/20/8	20/40–2
4	1941–47	30–40	250	20/40	20/20–1	20/20–1	20/20
5	1947–48	30–100	10	20/40	20/70	20/15	20/15
6	1947–48	20–100	30	20/40	20/30	20/20	20/20
7	1943–44	10	25	20/20	20/50	20/20	20/15
8	1939–42	70	100	20/20–4	20/20–8	20/15–1	20/15
9	1947–48	4–25	10	20/70	20/20	20/40	20/15
10	1938–40	15	80	20/20	20/20	20/15	20/15

* Patient 1 had one acute exposure of 35 n.

† LP = Light projection only.

appears that the afflicted men will not lose their vision irretrievably. All of the men involved are in reasonably good spirits and are carrying on productive activities professionally.

The accurate measurement of neutron intensities and energies is a rather difficult problem. To date most measurements have been made using equipment originally designed for use with x-rays. When a 100-r Victoreen chamber is exposed to fast neutrons and a full-scale reading is obtained, the instrument is said to indicate an exposure of 100 n. In many experiments it is convenient to use a 25-r Victoreen chamber and the resulting dose is expressed in N-units. In general, tissue dose in roentgen equivalent physical equals 1.5 n equals 2 N.

It is difficult today to estimate exposure occurring three to nine years ago. The individuals involved made independent calculations of their own exposures. The cumulative doses estimated were surprisingly low with a median dose 50 n.

At the time these men were receiving the exposure that led to cataracts, most were being given periodic blood examinations. In no case was there a change in blood picture to give a dramatic warning of overexposure to radiation. In only two cases was there a mild epilation. In general neutron irradiation of the head was greater than that to the whole body. Perhaps this accounts for the failure to observe blood changes.

It seems probable that the causative agent of the injury in most cases was chronic exposure to neutrons in the range 0-20 Mev. Evidence for this statement is rather indirect. The high energy radiation from the cyclotrons involved is principally neutrons and gamma rays. In most cases, the intensity as measured in an ionization chamber shows slightly more neutron than gamma-ray effect. Since not nearly enough gamma-ray intensity is present to produce cataracts, elimination leaves neutrons. The possibility does exist that the neutron effect might be enhanced by radiofrequency effects or by motion in the magnetic field of the cyclotron. However, the discovery of cataract production in mice by both cyclotron- and nuclear reactor-produced neutrons seems to make such complicating suggestions unnecessary.

In most cases, persons involved received their neutron exposure while at an angle of about 90° to the direction of a 8-to-16 Mev deuteron or proton beam. Target materials were variable and few measurements have been made by nuclear physicists of the particles emitted when particles of this energy strike targets of any kind. In most cases, there was little moderating material between the source and the lens.

A survey of the literature with respect to radiation cataracts reveals that considerable qualitative but little quantitative information is extant regarding cataracts induced by x-rays and gamma rays. Leinfelder and Kerr (*2*) have published one of the best studies of roentgen-ray cataract in humans. While their data involve a small number of cases, the indication is that approximately 2500 r is required to produce the effect. From supplementary studies on rabbits they found soft x-rays to be more damaging than hard x-rays, and that small doses of x-rays given over a period of time were less injurious than an equal acute dose.

Very little is known regarding cataracts produced by neutrons. The paper of T. C. Evans (*1*) provides the best information and indicates that the biological effectiveness of chronic doses of neutrons in producing lens abnormalities in mice may be as high as 8–40 times as great as x-rays. Insofar as the data from human eyes can be interpreted, it seems likely that with chronic exposure, the ratio of rem to rep for neutrons may likewise be as high as 10–40; that is, the ratio of roentgen equivalent man to roentgen equivalent physical may be as high as 10–40. Results given by R. S. Stone (*3*) are in accord with high biological effectiveness of chronic neutron exposure.

It should be emphasized that these figures for biological effectiveness of neutrons are merely the best estimates that incomplete and fragmentary data permit. In view of the implications of this finding, it is extremely important that further and more quantitative information be gathered from both animals and man.

It appears probable that if complete examination were made of all persons who have worked with cyclotrons, a further small group of afflicted individuals might be discovered. Most of the additional cases would probably be found not to be markedly handicapped. It is also possible that other portions of the body may be relatively highly affected by neutrons. For instance, the Evans experiments suggest, in mice, a selective sensitivity of the gonads as well as of the lens.

It is perhaps worth while to list a few of the areas of ignorance which have been highlighted by this unfortunate episode:

1. The exact causative agent is not definitely known;
2. The dose is imperfectly known;
3. Almost no systematic neutron research has yet been performed on organisms larger than a mouse;
4. There is little knowledge extant of what other organs of the animal may be especially susceptible to damage under special circumstances;
5. The concept of the rem (roentgen equivalent man) for neutrons and indeed for other new types of radiation is probably of limited value, since the conversion factor varies with tissue.

The National Research Council has appointed a Committee on Radiation Cataracts which is collecting additional information regarding others who have been exposed to neutrons. The committee will also conduct follow-up studies of those already known to be injured. Communications should be addressed to Philip S. Owen, M.D., Executive Secretary, Committee on Radiation Cataracts, National Research Council, 2101 Constitution Avenue, N. W., Washington 25, D. C.

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Sodium 2-Methyl-4-Dimethylaminophenylphosphinite, a Probable Methyl Donor[1, 2]

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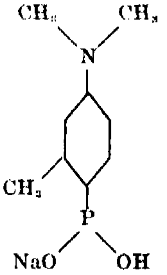
Previous investigations on biological methyl donors have shown evidence of a rather limited number of substances exhibiting donating properties, most of them being N-methyl compounds like choline. It is interesting to note that such N-methyl compounds, having the ability of giving methyl groups intact, show a similar basic structure—namely, they have their labile methyl groups bound with a quaternary or positive nitrogen (choline, betaine, dimethylethyl-β-hydroxyethylammonium chloride (*6*), tetramethylammonium formiate, methyltriethanolammonium iodide (*2*), etc. These observations fit in with the theory described by Du Vigneaud (*3*) based on the different ability of transmethylation shown by partially methylated aminoethanols and choline.

The relationship existing between structure and methylation capacity, described in the N-compounds cited, appears worthy of being generalized (*2*). Ciusa claims also that methyl compounds of arsenic, selenium, oxygen, and sulphur (*2*) may act as methyl donors when methyl groups are bound with electropositive atoms. A confirmation of this is obtained by experimental investigations on sodium cacodylate, and particularly in recent studies by Du Vigneaud on dimethylpropiothetin (*4*) and dimethylthetin (*5*).

A few recent observations from this laboratory concerning sodium 2-methyl-4-dimethylaminophenylphosphinite, which is used largely in therapy, are not in agreement with these assumptions.



The administration of this substance to human subjects, in normal conditions, causes a remarkable rise in urine elimination of N_1-methylnicotinamide, a product of the irreversible methylation of nicotinamide, introduced with diet and chosen as a test of the methylation activity (*2*).

We do not intend to take into consideration here details of technique, which are to be published later; we are reporting, instead, a few data obtained in this investigation, pointing out that the experiments have been performed on ourselves and on laboratory personnel, fed a rigorously standard diet, under normal conditions.

The values of N-methylnicotinamide reported herein refer to 24-hr urines. The administration of sodium 2-methyl-4-dimethylaminophenylphosphinite in a single therapeutic dose (30 mg), causes an immediate urinary increase in N_1-methylnicotinamide as seen in results in Fig. 1. The increase, in this case, is approximately 60%, while in other human subjects it has reached even higher values.

When the administration of the substance under observation is continued for several days in even small doses (15 mg), the elimination of N_1 is maintained constantly elevated above the normal, returning to the initial values as soon as the treatment is terminated. We do not believe the action of sodium 2-methyl-4-dimethylaminophenylphosphinite is attributable to a simple activation of methylation processes. The increased elimination, in fact, remains even when the subject is preventively treated and also treated during the experiment

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[1] We are greatly indebted to Mr. Cesare Barbieri and to the American Committee, University of Bologna, New York, for donation of the Beckman DU Spectrophotometer used in this investigation.

[2] The experiments have been performed with sodium 2-methyl-4-dimethylaminophenylphosphinite supplied by Consorzio Neoterapico Nazionale, Roma.

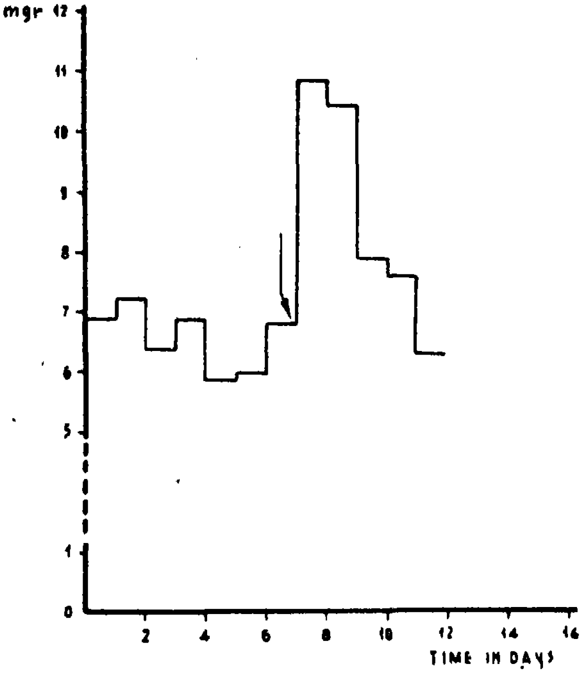


Fig. 1. Elimination of N_1 with urine. Arrow indicates the administration of 80 mg of sodium 2-methyl-4-dimethylaminophenylphosphinite.

with B_1, which regulates the elimination of urinary N_1, due to a probable catalytic action, carrying it to an almost constant level. These observations lead us, therefore, to believe that sodium 2-methyl-4-dimethylaminophenylphosphinite acts as a methyl donor.

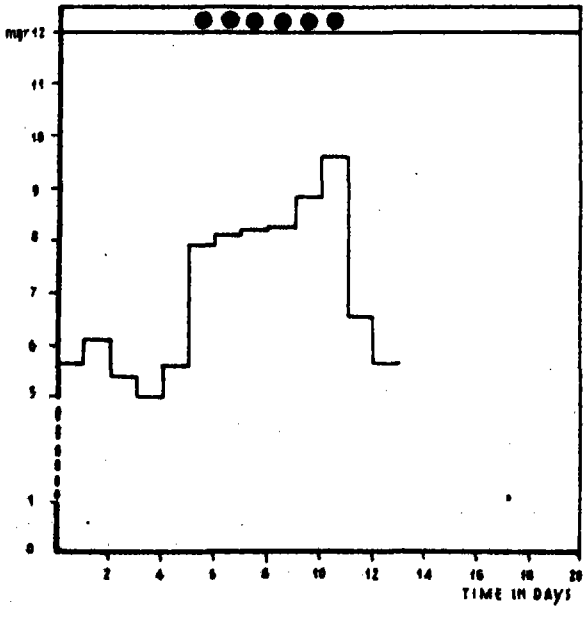
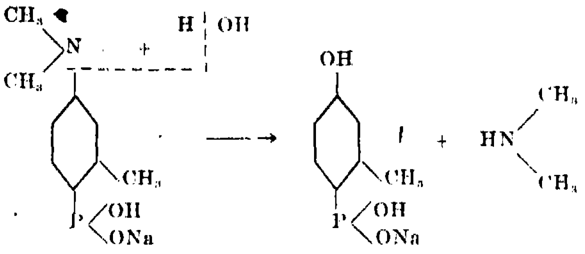


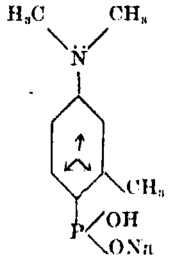
Fig. 2. Elimination of N_1 with urine after continuous treatment with sodium 2-methyl-4-dimethyl aminophenylphosphinite. Each ● indicates the administration of 15 mg.

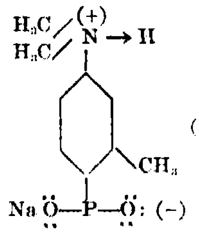
The interpretation of the mechanism which might explain this action is hypothetical. Analogously, along with *p*-nitrous dimethylaniline, we assume that also sodium 2-methyl-4-dimethylaminophenylphosphinite may yield dimethylamine as shown in the following:



The reaction may be enhanced by the presence of a methyl group in position 2 of the benzene ring which, being similarly oriented with other substitutes according to the Bonino (*1*) symbolism, (A) affords more mobility to the substitute in position 4. We do not believe, however, that dimethylamine is a methyl donor, noting that dimethylaminoethanol is a methyl acceptor rather than a methyl donor. It appears, instead, more probable that the methylation action of sodium 2-methyl-4-dimethylaminophenylphosphinite is attributable to a dipolar form (B):

(A)





(B)

in which is shown a positive nitrogen of N_1-methylated compounds acting as a methyl donor.

Our observations are in accord with the hypothesis cited (*2, 3*), and make evident a probably new methylating agent, the importance of which lies in its wide therapeutic use. These observations show also the interest which may derive from a structural study of substances of this type.

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Application of Perchloric Acid Technique to Protozoa

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In making a study of the cytochemistry of the ciliate protozoon, *Chilodonella uncinatus*, with the more familiar tests for nucleic acids and proteins, the perchloric acid technique recently developed by Ogur and Rosen (*2*) is of considerable interest. They have reported the extraction of nucleic acids from certain plant tissues with the use of perchloric acid. Their data indicate that prolonged contact in the cold with perchloric acid extracts pentose nucleic acid (PNA) but not desoxypentose nucleic acid (DNA); while at elevated temperatures, both of these are extracted from the homogenates. This leads them to conclude that cold perchloric acid appears comparable to ribonuclease. Their technique was adapted by us to slide analysis and was applied to *Chilodonella* in this manner:

The organisms were fixed in bulk in acetic acid-alcohol (one part acetic acid to three parts 95% alcohol). This fixative is particularly useful in that it also extracts the inorganic phosphates and does not interfere with any subsequent tests by the deposition of heavy metals. The organisms were affixed to albumin-smeared slides in the usual manner. After hydration the slides were processed in 2%, 5%, and 10% perchloric acid concentrations at various temperatures and for different lengths of time. After adequate washings they were stained with Feulgen (*4*), Unna-Pappenheim mixture, methyl green (*3*), and toluidine blue. Adequate controls were maintained by processing duplicate slides under the same conditions but without added perchloric acid. The results noted are based upon visual judgments using the compound microscope.

Results of the various treatments are as follows:

In any treatment, 2% or 10% perchloric acid, in the cold or at higher temperatures, the clearing of cytoplasmic basophilia in toluidine blue preparations and the lack of pyronin staining in Unna-Pappenheim mixture would seem to indicate that PNA is removed from the cytoplasm. The extent of PNA extraction in 2% perchloric acid in the cold depends, however, on the length of contact (see Table 1).

Two percent perchloric acid used in the cold, although apparently having no effect on the Feulgen reaction and thus on DNA, would appear to depolymerize this nucleic acid progressively, as shown by the decrease in methyl green staining capacity. Such structures of the nuclear apparatus that fail to stain with methyl green are stained with pyronin in Unna-Pappenheim mixture. According to Kurnick (*1*), such a reaction indicates the presence of a lower polymer, as pyronin stains only PNA and depolymerized DNA.

Ten percent perchloric acid at 5° C removes PNA very rapidly. In addition, our preparations of *Chilodonella* show that prolonged contact with the acid decreases the Feulgen staining capacity of the nuclear apparatus. It would seem that DNA is also being extracted. The methyl green preparations are even more striking; at 72 hr the reaction is essentially negative.

TABLE 1
DETAILS OF TREATMENT WITH PERCHLORIC ACID ON *Chilodonella uncinatus*

% $HClO_4$	Temp (C)	Time (hr)	Results	
			cytoplasm	nucleus
2	5°	8, 10, 18, 24, 72	Progressively decreased basophilia, beginning at about 10 hr.	Feulgen reaction remains unchanged. Methyl green intensity decreases progressively starting at about 18 hr.
10	5°	3, 10, 18, 24, 72	No basophilia.	Feulgen intensity progressively decreases. Methyl green staining becomes less intense, until at 72 hr it is practically nil.
5–10	35°	18	No basophilia.	Feulgen as well as methyl green staining are very faint.
5–10	70°	20 min	No basophilia.	Feulgen and methyl green reactions are negative.

Five percent or 10% perchloric acid at temperatures of 35° C and above is capable of extracting DNA quite rapidly, total extraction occurring at 75° C where, within 20 min, the nuclear apparatus becomes Feulgen negative and the cytoplasm shows essentially no basophilia. However, hot water treatment of the animals reduces the staining intensity with the specific stains, Feulgen and methyl green. In particular, the methyl green reaction becomes rapidly negative. It is thus extremely important to carry adequate controls before interpreting results.

It seems possible that in *Chilodonella*, cold perchloric acid on prolonged application is able, in addition to extracting PNA, to depolymerize DNA. This depolymerization might be an essential preliminary step in the process of extraction of this nucleic acid. The extraction appears to take place to a considerable extent in 10% perchloric acid in the cold, indicating that rather rigid conditions may be necessary before a parallel between the actions of perchloric acid and ribonuclease can be established. It may be noted, however, that the nuclear apparatus of *Chilodonella* is unique in many respects, and the reactions that one finds here may not necessarily be applicable to other animal cells or even to other protozoa.

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[1] We wish to express our thanks to Dr. D. H. Wenrich for his interest and criticism.

The Use of Triphenyltetrazolium Chloride for the Study of Respiration of Tissue Slices

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In 1948 Strauss, Cheronis and Straus suggested the use of triphenyltetrazolium chloride for the differentiation of cancer tissue from surrounding normal tissue. The authors indicated that tumor tissue would reduce the dye more readily than normal tissues (*2*). The use of triphenyltetrazolium chloride was also mentioned by Kun and Abood (*1*) in a study of the respiration of tissue homogenates. Our paper will describe a technique whereby the respiration of tissue slices may be measured with the aid of 2,3,5-triphenyltetrazolium chloride, and will present some results of these measurements.

The tissues which were studied include liver, kidney, spleen, diaphragm, small intestine, and spontaneous mammary carcinoma, all from CFW mice. With the exception of the diaphragm, tissues are sliced freehand, at a thickness of approximately 0.5 mm. The diaphragm was not sectioned, since it is thin enough to permit ready diffusion. All sections were run in duplicate so that reproducibility of the results could be evaluated.

The animal was usually killed rapidly by crushing the cervical cord, and sections of the organs were made within a few minutes of death. The tissue sections were placed in wide-mouthed test tubes (1.5 × 10 cm) and 5 ml of normal saline was added to remove blood and extraneous material. The solution was then decanted and 3 ml of the buffered (pH 7.2) 1% tetrazolium solution in distilled water was added. The tubes, placed in a rack in an incubator maintained at 37° C, were agitated gently by means of a mechanical shaker. After incubation the tubes were removed, the tetrazolium solution was decanted, and the red color of the reduced tetrazolium extracted with acetone. The extraction was a quantitative one accomplished by means of repeated washings with acetone. Each washing was added to a Klett colorimeter tube. Usually four washings of 2 ml, 1 ml, ½ ml, and ½ ml were sufficient to remove all the color from the tissue. The acetone in each colorimeter tube was then diluted to the 5-ml mark with additional acetone, and after thorough mixing, the intensity of the color was read in a Klett-Summerson photoelectric colorimeter, using the green No. 42 filter. The tissues were allowed to dry at room temperature, a procedure which was accomplished rapidly because of the previous acetone dehydration. The tissues were then weighed on an analytical balance and the color reading determined per mg of tissue. The color readings can also be converted to gamma of tetrazolium reduced, by the use of a standard dilution curve of reduced tetrazolium as indicated by Kun and Abood.

TABLE 1

REDUCTION OF TETRAZOLIUM BY DUPLICATED TISSUE SLICES (30-MIN INCUBATION)

Tissue	Colorimeter reading	Tissue weight in mg	Reading per mg
Liver, a	131	3.1	42.2
Liver, b	140	3.1	45.1
Kidney, a	88	1.6	55.0
Kidney, b	226	3.7	61.0
Tumor, a	120	6.7	17.8
Tumor, b	146	7.3	20.0

The values obtained by this technique were reproducible in duplicate slices as shown in Table 1. The mean values as well as the spread of values for the endogenous metabolism of the various tissues of CFW mice, with and without spontaneous mammary carcinoma, are shown in Table 2.

It will be noted that the values obtained are similar in tissues from animals with and without spontaneous breast carcinoma. The only apparent exception to this is in the case of the diaphragm after 30-min incubation, where the mean value obtained was lower in the presence of the tumor. However, after a 60-min incubation period the mean values were identical. The relative intensity of the endogenous metabolism as measured by this technique (with 1-hr incubation) is in the following order: kidney, liver, duodenum, diaphragm, tumor, spleen. It also appears significant that while the kidney, liver, and duodenum show increased reductions of the dye after 60-min incubation as compared with 30-min incubation, this was not the case with the tumor and spleen, wherein little change occurred, and with sections of diaphragm, where an actual decrease in values was observed. The exact significance of this observation is not clear at present and is being studied further.

TABLE 2

COLORIMETRIC ESTIMATION OF REDUCTION OF TRIPHENYLTETRAZOLIUM CHLORIDE BY TISSUE SLICES

Organ	No. animals	Lowest value	Highest value	Mean	No. cases	Lowest value	Highest value	Mean
	Female CFW mice with spontaneous mammary carcinoma							
	30-min. incubation				60-min incubation			
Liver	10	33	53	40	7	47	82	65
Kidney	10	41	63	55	5	79	112	99
Diaphragm	5	19	48	33	4	20	37	29
Small intestines	2	43	50	46	4	39	76	56
Tumor	7	7	33	17	4	18	24	22
Spleen	4	11	41	22	13	8	32	18
	Male and female CFW mice without tumor							
Liver	6	34	52	41	17	53	98	68
Kidney	6	44	71	52	12	83	141	91
Diaphragm	5	24	76	52	5	20	36	29
Small intestines	4	26	55	41	4	39	77	56
Spleen	2	9	18	15	7	10	32	16

This technique is also applicable to the investigation of the effects of enzyme inhibitors on tissue respiration.

Thus the addition of sodium azide to the tetrazolium solution resulted in depression of the reduction of the dye. Typical results are indicated in Table 3, which presents the mean values for tissues from six animals, the experiments having been done in duplicate.

TABLE 8

EFFECT OF NaN_3 ON REDUCTION OF TRIPHENYLTETRAZOLIUM CHLORIDE BY TISSUE SLICES

Tissue	R_0*	% Change 10^{-3}M	NaN_3† 10^{-6}M
Liver	44	−45	−11
Kidney	55	−36	− 2

* R_0 = Colorimeter reading/mg tissue, dry wt, 80-min incubation.

† Sodium azide, 0.5×10^{-3}M and 0.5×10^{-6}M added to 3 ml of 1% tetraphenyltetrazolium solution.

It appears from the data presented that triphenyltetrazolium chloride may be used in a simple and reproducible manner to study the metabolism of tissue slices and the effects of enzyme inhibitors.

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Electrolytically Induced Reactions

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Recently two examples of a novel type of induced reaction have been observed in this laboratory. Both reactions are unique in being electrolytically induced. The first is the electrolytically induced air oxidation of trivalent arsenic, As^{III} in alkaline solution. It has been observed (*1*) that air oxidation of As^{III} in a solution 1*N* in sodium hydroxide is slight. But if electrolytic oxidation of the arsenic is carried on in the same solution, oxidation occurs up to 50% in excess of that corresponding to the current used. This excess oxidation is attributed to oxygen of the air, since it is entirely eliminated if the surrounding air is displaced with nitrogen. The electrolytic process, however, seems essential.

The second reaction is the electrolytically induced precipitation of iridium with rhodium. It was observed by MacNevin and Tuthill (*2*) that iridium could not be deposited from an ammonium chloride solution at cathode potentials as great as −1.0 volt. But if rhodium is also present, then not only does the rhodium precipitate quantitatively at a cathode potential of −0.3 volts, but the major part of the iridium does also.

These two reactions are considered to be examples of a new type of induced reaction and it is proposed to call them "electrolytically induced" reactions.

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The Isolation of a Metabolite of Pentobarbital[1]

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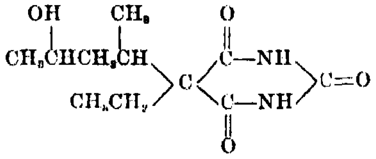
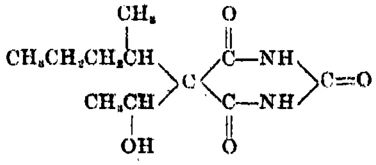
There is general agreement that pentobarbital is excreted only in trace amounts in the urine (*2*, *6*, *8*, *9*), but up to the present no metabolic products of the drug have been reported. It has now been found possible to isolate a metabolite of pentobarbital from the urine of dogs after anesthetic doses of the drug. The compound melts at 209–210° C and has an elementary composition corresponding to pentobarbital with one additional oxygen atom ($C_{11}H_{18}O_4N_2$). In sodium hydroxide solution it has the characteristic ultraviolet absorption spectrum of the dialkylbarbituric acids (*5*). In the range of 225–290 mμ the absorption curve has exactly the same shape as that of pentobarbital, but the extinction is about 7% lower. This would imply a molecular weight of about 242 for the new barbiturate. Further evidence for the barbituric acid ring was obtained by the preparation of a di-*p*-nitrobenzyl derivative (*3*).

The presence of a hydroxyl group was demonstrated by the reaction of the metabolite with acetic anhydride. A new compound was formed which crystallized from aqueous ethanol in the form of blunt needles; mp 147–148° C. It had the elementary composition of the corresponding acetate ($C_{13}H_{20}O_5N_2$). On treatment with sodium hypoiodite in dioxane solution the metabolite yielded iodoform. It would thus appear that the compound could be either I or II. Structure II would not seem likely, however, because such a compound would probably react with sodium hypoiodite to yield acetic acid, not iodoform.



(I)



(II)

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[1] This work was supported by a grant from the U. S. Public Health Service.

There are other reasons for favoring structure I. It would appear that ethyl groups attached to the barbituric acid ring do not suffer change in the body. For example, diethylbarbituric acid is excreted unchanged (*1, 4, 7*). Increasing the length of one of the chains increases the activity, but the molecules are then more susceptible to chemical change in the liver. Up to now it has not been known whether the change in the barbiturates was due to oxidation, hydrolysis, conjugation, or a combination of these reactions. It now appears likely that direct oxidative attack of side chains containing four or more carbon atoms is an important part of the chemical alteration of such compounds in the body.

The product of biological oxidation of pentobarbital is asymmetric. The isolated barbituric acid is dextrorotatory in acetic acid: $[\alpha]_{D}^{26} = +26.6°$. It was also found to be without apparent pharmacological action after intraperitoneal injection of a large dose (180 mg/kg) into mice. Further details of this work and other experiments in progress will be reported elsewhere.

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Detection of Radioactive Impurities by the Constant Solubility Test[1]

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In work with radioactive compounds, it is of importance to establish that significant amounts of the radioactivity measured in the labeled materials are not due to impurities. This is especially true in biological experiments in which the metabolism of a labeled compound is followed solely on the basis of radioactivity measurements. Radioactive contaminants in crystalline material often represent an amount by weight much smaller than can be detected by the common criteria of chemical purity. Specific procedures have been developed which take this problem into account (*1*). Recrystallization to constant specific radioactivity, conversion of the product to a derivative without change of specific activity, and determination of the distribution coefficients between two immiscible solvents have been used to prove the purity of radioactive materials.

A modification of the solubility method of analysis[2] has been devised for the detection of minute amounts of radioactive impurities in chemical compounds. This method is especially suited to the estimation of the purity of a radioactive compound because of the high sensitivity inherent in radioactivity measurements and because of the theoretical soundness of the phase rule. The simplicity of the technique and the easy recovery of the compounds used in the tests recommend it when limited amounts of material are available.

TABLE 1

SOLUBILITY TEST OF PURITY OF RADIOACTIVE S-BENZYL-D-HOMOCYSTEINE-S^{35}*

Time	Radioactivity of solution†	
	counts/sec/ml	
hr	flask A	flask B
16	24.0	24.4‡
40	23.6	23.4

* The specific radioactivity was 0.43 counts/sec/γS.
† The solvent was water at 29.3° C.
‡ After this measurement 12.6 mg of solid was added.

The principle of the constant solubility test as adapted to the detection of radioactive impurities is illustrated in the following general procedure, which should be applied to a compound judged to be chemically pure: A solvent is selected in which the compound is sparingly soluble; a convenient volume of the solvent is saturated with the compound by equilibration at constant temperature; a sample of the saturated solution is withdrawn and its radioactivity is measured; more of the compound is added to the solution, and after a suitable time interval for equilibration the radioactivity of the supernatant liquid is again determined. If the compound is impure, addition of more solid will increase the concentration of impurities in the liquid phase. Radioactive impurities will increase the radioactive count per unit volume of the solution. In the absence of radioactive impurities, the radioactivity of the two samples of solution will be the same.

The sensitivity of the method is utilized to its fullest extent by employing, in the first equilibration, an amount of solid just sufficient to saturate the solution, and by adding as large an amount of solid as feasible before the second equilibration. Considerable procedural variations within the principle of the solubility test are possible. Two applications of the method are given here for illustration.

The purity of three times recrystallized S-benzyl-D-homocysteine-S^{35} was demonstrated as shown in Table 1. This material had attained constant radioactivity in successive recrystallizations and had been converted to N-acetyl-S-benzyl-D-homocysteine-S^{35} without change in the specific radioactivity of the sulfur. Three mg of the compound was suspended in 5 ml of distilled water in each of

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[1] This work was supported by grants from the American Cancer Society, upon recommendation from the Committee on Growth of the National Research Council, and by the Rockefeller Foundation.

[2] For a discussion of the scope and limitations of the solubility method of analysis as a criterion of purity see Herriott, R. M., *Fed. Proc.*, 1948, **7**, 479.

TABLE 2

DETECTION OF RADIOACTIVE IMPURITY IN L-CYSTINE

Time	Radioactivity of solution*
hr	counts/sec/ml
3	2.6
6	2.9†
19	34.9

* The solvent was water at 0° C.

† After this measurement 15.1 mg of compound was added.

two flasks. After equilibration for 16 hr, 0.5-ml samples were withdrawn through pipettes fitted with cotton filters, and the radioactivities of the solutions were determined. To one flask was added 12.6 mg of the compound and equilibration was continued for another 24 hr. At this time measurements showed that the radioactivity of both solutions had remained constant.

The presence of impurities was demonstrated in the following experiment: A sample of chemically pure L-cystine was deliberately contaminated by crystallization from a solution containing a mixture of radioactive sulfur-containing compounds. The apparent specific radioactivity of the recovered cystine was 0.039 counts/sec/γ S. A sample of 1.5 mg of the radioactive compound was suspended in 6 ml of distilled water and samples were withdrawn after equilibration for 3 and 6 hr respectively. After 6 hr, 15.1 mg of the compound was added to the flask and an additional sample was taken after further equilibration for 19 hr. The increase in radioactivity of the solution after addition of more solid (Table 2) proved that the compound contained radioactive contaminants.

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Some Observations on Exchange of CO_2 Between $BaCO_3$ and CO_2 Gas[1]

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Previous studies on the exchange of CO_2 between $BaCO_3$ crystals and atmospheric CO_2 have shown that exchange takes place in the presence of moisture (*1*), and that the amount of exchange can be reduced by heat treatment of the $BaCO_3$ samples (*2*). An attempt has been made to confirm these results, and to obtain additional information on the factors which affect the amount of exchange, using C^{14}.

The original $BaCO_3$ had a specific activity of about 1.2×10^6 cpm/mg.[3] It was attempted to prepare an active $CO_3^=$ solution by heating this material with inactive 0.1*N* Na_2CO_3 for 1 week. However, no exchange occurred. Active $CO_3^=$ was then prepared by mixing active $BaCO_3$ with varying amounts of ordinary $BaCO_3$, evolving the CO_2 by treating with 3*N* HCl in a small glass generating apparatus, and passing the evolved CO_2 in a small stream of N_2 gas through a coiled glass tube filled with 3*N* NaOH solution. After absorption of CO_2, the NaOH solution was removed from the apparatus and diluted about threefold, and $BaCO_3$ was precipitated, in the cold, with $BaCl_2$ solution. This was then filtered and washed with water, alcohol, and finally acetone to hasten drying. The filter paper with the precipitate was pasted to aluminum disks for easier handling and to prevent curling upon drying.

The effect of different amounts of moisture on the amount of exchange was studied first. The method used was to expose the sample to inactive CO_2 in a static atmosphere of known relative humidity, and to compare the counting rates of the sample before and after exposure. This was performed in a closed desiccator, as shown in Fig. 1. The bottom of the desiccator contained sulfuric acid solution of a density adjusted so that a known constant relative humidity was obtained.

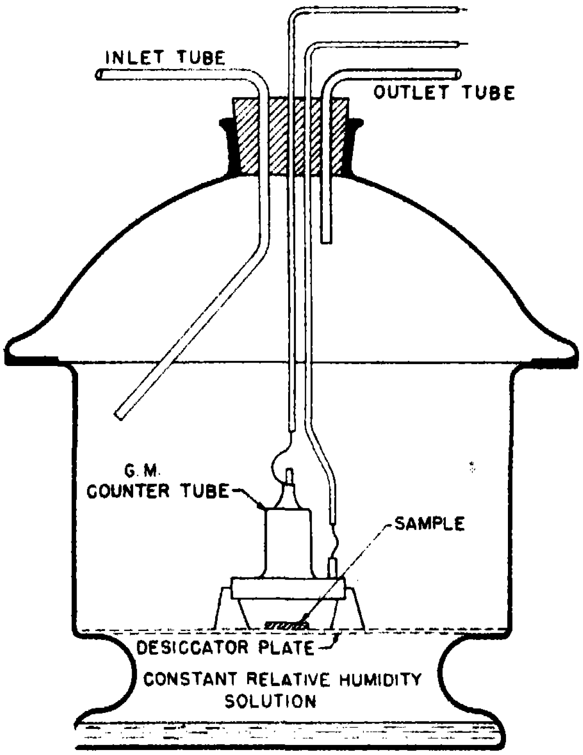

FIG. 1.

The sample was placed beneath the tube and counted. CO_2 was passed into the desiccator for 15 min and then the vessel was sealed for 2 hr. At the end of this time, air was blown through to sweep out the CO_2, and the sample was recounted.

The addition of CO_2 into the desiccator causes the count to drop 25% to 40% of the count in air, due to increased absorption of β-rays by CO_2. However, all counting was done with air in the desiccator.

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[1] Research work done at the Brookhaven National Laboratory under the auspices of the Atomic Energy Commission.

[2] I wish to thank Dr. William Rubinson and Dr. Warren Miller for helpful advice.

[3] Obtained from Oak Ridge.

The results of the first set of experiments are given in Table 1. Each line represents a freshly prepared sample.

TABLE 1

Relative humidity in %	Wt of sample in mg	% Decrease in counting rate	
3.2	17.7	1.5	Prob. Error
3.2	15.8	1.2	
47.2	16.9	1.3	± 0.3%
47.2	17	1.3	
47.2	16.8	1.4	
75	17.3	1.4	
75	20.7	2.5*	
18.8	14.7	2.4*	± 0.5%
18.8	13.7	2.3*	
18.8	14.2	2.3*	

* Samples were prepared from a different active Na_2CO_3[4] solution.

The decrease in counting rate after exposure is taken to be a measure of the amount of exchange between CO_2 and $BaCO_3$. The results indicate that the amount of moisture present has no effect on the amount of exchange, at least so long as the relative humidity exceeds 3%.

Armstrong and Schubert (*1*) reported that thorough mechanical mixing of the barium carbonate after treatment caused no change in activity. This was interpreted as proof that exchange took place throughout the sample. This conclusion was confirmed by a different method, as follows.

A group of five samples was made up, each containing the same amount of activity, but varying in weight in steps up to 10 mg. Each sample was exposed to CO_2 in the manner already described, except that the CO_2 was moistened before being passed into the desiccator. The bottom of the desiccator contained water. After 2 hr the CO_2 was blown out and the sample was counted.

TABLE 2

Sample thickness mg/cm²	Loss of $C^{14}O_2$ in %	
0.56	3.8	Prob. Error
2.13	3.8	
2.59	3.8	
3.24	3.8	± .5%
4.44	3.9	
1.3	2.6*	
1.6	2.8*	
2.3	2.5*	

* Samples made from a new batch of Na_2CO_3 solution.

These results indicate nothing about the amount of exchange undergone by a single crystallite in the sample, but they do show that all crystallites in the body of the sample suffer exchange.

The following experiment was set up to determine the effect of heating on $BaCO_3$ samples. Yankwich (*2*) reported that heating $BaCO_3$ resulted in samples that could be stored for long periods without serious loss of activity. Several samples were heated separately in air for ½ hr, 1 hr, and 1½ hr at 140° C. Each sample was then exposed to moist CO_2 for 2 hr and counted. Those samples which were heated for 1½ hr showed no exchange. Those which were heated for less time showed small, varying amounts of exchange.

TABLE 3

Preparation	Particle size	Exchange %	
Samples prepared by slow pptn. from hot soln.	Coarse crystals	0.0	
Samples pptd. at room temperature	Fine ppt., readily filterable	1.8	Prob. Error
		1.7	
Samples prepared from ice cold soln.	Fine ppt., clogged filter	4.5	± .6%
		4.5	

It was found that heating an active sample in air caused a loss of activity varying between 2.5% and 3%. However, when the samples are heated in an evacuated bulb, or in an atmosphere of nitrogen, this loss does not occur, and the sample is stabilized against subsequent exchange.

The next group of experiments was to determine what effect particle size had on the amount of exchange. Three sets of samples were made up. One set was made by dropwise precipitation over a 2-hr period from a very dilute solution kept at just below boiling temperature. Another was made at room temperature, and a third was made with a concentrated $BaCl_2$ solution from a semi-frozen solution of Na_2CO_3. Table 3 shows the results.

The final experiment was designed to get some idea of how the percent exchange depends on the time of contact. The rate of flow of CO_2 into the desiccator was kept as constant as possible from one sample to the next. After the CO_2 was blown into the desiccator for the time required the flow was turned off, and immediately air was passed through for 15 min. The samples for this experiment were precipitated from ice cold Na_2CO_3 solution to take advantage of the higher percent exchange which can be obtained by this procedure. The results are given in Table 4, and suggest that under these conditions, the exchange has almost reached its limiting value in 15 min.

TABLE 4

Time CO_2 was in contact with sample, in min	% Loss	
15	3.8	Prob. Error
15	4.1	
10	3.7	
10	3.2	
5	2.4	± .4%
5	2.3	
5	2.1	
2	2	
1	1	

The observations indicate that a small amount of moisture will be sufficient to cause exchange between $BaCO_3$ and atmospheric CO_2. However, the amount of exchange taking place depends on the size of the particles; the larger the particles, the less the exchange. This indicates that exchange takes place on the crystal surface. Heating of the $BaCO_3$ sample or preparing it by some method giving very large crystals will make exchange negligible.

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[4] All Na_2CO_3 mentioned in the article contains active carbon.

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Modifications of the Rabbit Ear Chamber Technique[1]

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The rabbit ear chamber provides a valuable technique for the microscopic study of living vascular tissue over a period of weeks or months. The basic design has been described (*1–3*), but in the course of the past three years various modifications have been made which simplify the procedure. Since the changes may be of help to others using the method, they are presented here.

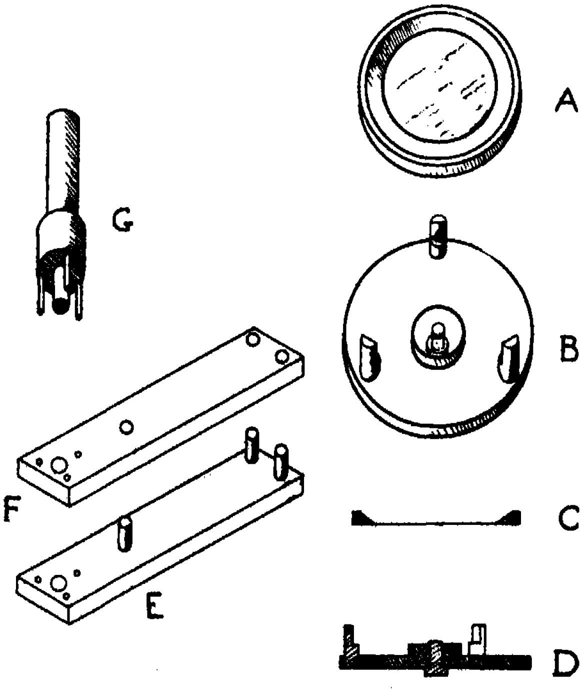

Fig. 1.

A modified chamber has been designed, constructed entirely of Plexiglas except for a mica cover slip. The cover slip's supporting ring (*A*) has an outside diam of ⅞ in. and an inside diam of ⅝ in. It is 0.080 in. thick. The top is beveled at the angle shown in cross section (*C*) to prevent high power objectives from striking the edge of the ring. A piece of clear mica 50–60 μ in thickness is glued to the supporting ring (*A* and *C*).

The chamber base (*B* and *D*) has a diam of 1 in. and the base plate (*B* and *D*) is 1/16 in. thick. A central observation table ¼ in. in diam projects 3/32 in. above the base plate. If access to the thin layer of tissue on the table is desired, a removable plug with a shaft diam of 1/16 in. may be made to fit loosely into a hole drilled through the base plate and central table (*B* and *D*). It is important to have this fit loosely, because serum which seeps around the plug makes it difficult to remove the plug after new tissue has grown onto the observation table.

The cover slip ring (*A* and *C*) fits tightly onto three notched Plexiglas pegs (*B* and *D*), 0.109 in. in diam, inserted at the periphery of the base plate and cemented with glacial acetic acid. The notches (*D*) are elevated .002 in. above the level of the table. The height of the notches above the table determines the thickness of the new tissue which grows between the cover slip and observation table and eliminates the need for buffers previously described (*1, 2*). After the ring has been snapped into place, it is secured by a drop of Lucite in chloroform over each peg.

The operative technique for inserting the chamber has been described (*1, 2*). To insert the chamber, four holes are punched through skin and cartilage near the tip of the pinna; a central hole to accommodate the central table and three peripheral holes for the pegs. A steel punch (*G*) has been designed to cut the four holes at one time and insure an exact fit. Three peripheral punches are attached to a handle in the exact positions of the Plexiglas pegs and made 0.015 in. larger than the diam of the pegs. A fourth punch, 0.015 in. larger than the central table diam, is attached centrally. The punches are ¾ in. long and have notched ends. A Plexiglas guide (*E, F*) permits visualization of vessels when holes are punched and keeps the ear perfectly flat. The guide is made in two pieces, each 5¾ in. in length, 1¼ in. wide, and ⅜ in. thick. Steel connecting pins, ⅜ in. long and 3/16 in. in diam, connect the two plates when in use. Punch holes are placed at one end and are made 0.001 in. larger than the diam of the corresponding punch. The end of the ear is slipped between the two plates and when the template has been placed so that the central artery is adjacent to the central hole and no major vessels will be cut by the punches, the plates are pressed tightly together. The guide is then held firmly against the table and the holes are punched.

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3. Sandison, J. C. *Amer. J. Anat.*, 1928, **41**, 447.

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[1] This investigation was supported by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service.

Comments and Communications

On the Mental Ability of the Dog

As part of a long range research program on the relation between genetics and behavior, we are very much interested in the problem of mental ability in the dog. We therefore read the communication entitled "Concerning a Dog's Word Comprehension" (*Science*, May 13, p. 494) with great interest. While we are probably sufficiently biased to believe that the reported word comprehension ability is true, we are not convinced that the evidence is sufficient to be passed off as a scientific fact. There can be no question but that the dog is an intelligent animal —how intelligent, and what factors of intelligence it possesses remain to be experimentally demonstrated. We are assembling a battery of mental tests for the dog by means of which we believe it may be possible eventually to demonstrate the existence of the factors of space perception, memory, reasoning, and movement perception.

The point to be made here is that there can be no question that the dog is capable of what we might call intelligent behavior. The question is whether the dog's understanding moves over into the realm of our particular language. The report of Eckstein smacks of the "anecdotal" period of comparative psychology and is replete with lack of even obvious controls. As examples, no mention is made of the "Clever Hans" error, apparently no trials were made in which the experimenter said (in the same tone of voice) "La mesa, Topper," or "Borscht, Topper," not to mention the fact that there is complete lack of any statistical consideration of the element of chance with respect to the animal's behavior.

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Citation of Botanical References

The present confusion in citing botanical references, with some publications following several conflicting systems and others without consistent practice, is absurd in an orderly science. A standard system is badly needed. Perhaps a simple set of rules for citation could be formulated and adopted by representatives of botanical societies, editors of botanical publications, and bibliographers at an annual scientific meeting, such as that of Section G of the American Association for the Advancement of Science at New York City this month.[1] Then, at the Seventh International Botanical Congress at Stockholm next year, further efforts should be made to obtain international agreement upon a uniform system for citations which the majority of botanists in many countries will accept and follow voluntarily.

Some years ago, E. D. Merrill (*Science*, 1925, 62, 419) suggested shorter and simpler ways of citing scientific references, remarking that the average editors and authors were ultraconservative. As he stated, an author preparing a paper for a certain journal and then later submitting it to another frequently has to rewrite parts to conform to the different style of citations used in the second. Some authors have the attitude, "What's the use of having an editor, if not to do these chores?" An editor quoting that remark, C. A. Shull (*Science*, 1931, 73, 363), justly criticized authors for carelessness and mistakes in spelling, citing titles, volumes, years, etc.

An anonymous university scientist (*Amer. Sci.*, 1947, 35, 306 ff.) has advocated that, instead of striving for consistency in citations and other details, editors should relax and accept an author's own tastes and print the manuscripts as they come, provided they are done in some regular manner. As a possible solution he suggested the voluntary adoption of a uniform standard by journals generally or by separate branches of science through a representative body, such as The Society of the Sigma Xi or the AAAS.

Apparently the only system for citations officially accepted by a representative group of botanists in the U. S. was the *Rules for Citation* adopted in 1893 by the Botanical Congress in Madison, Wisconsin, and by Section G, AAAS (reprinted in *Bull. Torrey bot. Club*, 1895, 22, 130). These *Rules*, only two pages long, were summarized in a paragraph by Lazella Schwarten and H. W. Rickett (*Bull. Torrey bot. Club*, 1947, 74, 348).

Noting that the good, widely used Madison *Rules* have stood the test of time, Rickett (*Bull. Torrey bot. Club*, 1948, 75, 166) has proposed that, with certain desirable modifications, they be given international authority by the next International Botanical Congress. He has further proposed that the editors of the next edition of the *International rules of botanical nomenclature* be instructed to bring its present inconsistent citations into conformity and that the rules for citation be inserted as an appendix to serve as a model for future use (Camp, W. H., Rickett, H. W., and Weatherby, C. A., compilers. *Brittonia*, 1947, 6, 3; and *ibid.*, 1949, 7, 51).

However, the Madison *Rules* seem rather brief for covering the enormous volume of botanical literature with complex citations which has arisen in the present century. A system which has been in use more than 50 years should be improved by some revision, anyway. I urge the botanists within the U. S. to act promptly now and agree upon a set of rules for citation before requesting international approval at the Stockholm Congress in 1950.

First, several more or less obvious general principles should be established. In nontechnical publications for general readers it may be best to list references in full.

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[1] An open discussion meeting on botanical citations in the literature now has been scheduled for the New York City meeting at 9 : 30 p.m., Tuesday, December 27, in the Colonial Room of Hotel McAlpin under sponsorship of the Committee on Publications of the American Institute of Biological Sciences.

The chief purposes of shortened citations of botanical references are to save time of authors and readers and to save space and to avoid repetition on the printed page. Though a citation should be short and simple, clarity must not be sacrificed to achieve brevity. Citations should be sufficiently clear not only to specialists in a narrow field of botany but also to botanists in general, workers in applied plant sciences and related fields, editors, and librarians. Citations should not be so short that readers waste time in deciphering them, nor so ambiguous that they fail to guide readers to the correct volume and page. Within one article, and among the issues of the same periodical, citations should be consistent. And wide, voluntary adoption of the same rules by many different periodicals and serials is an important objective.

Botanical indexes and bibliographies. Each of the four leading botanical indexes and bibliographies published in the U. S. has its own system of citing references. "Index to American Botanical Literature," published bimonthly in *Bulletin of the Torrey botanical Club,* and also printed on cards for libraries, began in 1886 and is the oldest. It follows the Madison *Rules* and its own published list of abbreviations of periodicals by Schwarten and Rickett and is now prepared in the library of the Arnold Arboretum of Harvard University.

Each monthly issue of *The Agricultural Index* contains a list of abbreviations used for the periodicals and bulletins indexed. This system of extreme abbreviations without periods, like that in city telephone directories, may be justified for special bibliographies to save space and expense, but is not a model to be followed by botanists in their scientific writings. *Biological Abstracts* has no published summary of its rules but in each May issue lists, without abbreviations, the periodicals and serials covered.

Bibliography of Agriculture, a monthly publication of the U. S. Department of Agriculture Library, follows the Department of Agriculture's *Citations to literature* by Carolyn Whitlock (*Citations to literature in the* Journal of Agricultural Research, *technical bulletins, circulars, and miscellaneous publications* [*other than bibliographies*], U. S. Dept. Agric., 1940), which was published in 1940, replacing shorter rules issued in 1927. It adopts, with nine shortened exceptions, *Abbreviations used in the Department of Agriculture for titles of publications,* also by Whitlock (*Misc. Publ. U. S. Dept. Agric.*, 1939, **337**, 278 pp.). These directions for citations have been developed through the years by the Department of Agriculture, the largest institution of plant scientists in this country.

If as many as three of these four indexes and bibliographies could agree in citing botanical references, this system probably would become widely adopted throughout the U. S. Then international agreement would be simpler when compromises with systems in other countries and other languages are sought.

Revised rules. A uniform system of rules for citation could be developed through consolidation of the two-page Madison *Rules* for citation and the 15-page *Citations to literature* used in the U. S. Department of Agriculture into one of intermediate length with some exceptions permitted. There should be many well-chosen examples of both ordinary and complicated references.

With the main rules of the Department of Agriculture as a base, I shall list some of the more important features of a proposed revised system, including several items upon which agreement is unnecessary and omitting minor details. The revised rules should provide separately for the two groups of botanical references, books, and articles in periodicals.

The essentials of a reference in the two groups, as quoted from the Department of Agriculture directions (p. 2), are:

> A book citation should include author, date, title, edition (except first), pagination or volume, illustrations, and place of publication. Important series may be noted.
>
> A periodical citation should include author, date, title of article, title of periodical, series, volume, pagination, and illustrations. Number or part is given only when it is separately paged, or is necessary for finding the reference easily.

The revision should contain additional provisions for citation of scientific names, the special, shortened form used by plant taxonomists in citing place of publication of scientific names of plants, including synonyms. Many details are the same as in book and periodical references, but the differences are beyond the scope of this article.

In some periodicals, as well as U. S. Department of Agriculture publications, the listed references are numbered and cited in the text by number. In others they are cited in the text by author and year. Each method has certain advantages and limitations.

Book citations. Citations of author and title are the same for both books and periodical articles and seldom present problems. Special cases are covered in the Deparment of Agriculture directions (pp. 4–9). Name of author should be given as in original publication, rather than with initials only, and the title, unless it is very long, is cited in full.

In ordinary botanical citations the less important items, not needed in finding the reference, are preferably omitted. These items include the preliminary pages of a preface or introduction, numbered with Roman numerals, the number and kinds of illustrations, and the name of the publishing company. The abbreviation "illus.," as used by the Department of Agriculture, is sufficient to indicate that the reference is illustrated. Where desirable, numbers and kinds of illustrations may be indicated by "pl." for plate and "f." for figure. However, use of italics for illustrations, as provided in the Madison *Rules*, is not general and should remain optional. Arabic numerals are better, even for plates bearing Roman numerals. Definite action should be taken on whether to abbreviate pages as "p." or "pp."

Periodical citations. These differ from book citations chiefly in including an abbreviated title of the periodical. The Madison *Rules* call for series in Roman capitals, whereas the Department of Agriculture directions state that series numbers should be set off by commas (my choice) or in parentheses preceding volume number.

Under both systems, volume numbers are in Arabic numerals, followed by colon, space, and page number. However, boldface numerals for volumes, specified by the Madison *Rules* and supported by Rickett (*Bull. Torrey bot. Club*, 1947, **75**, 166), are not used by the Department of Agriculture and should be optional. They require extra care and time of author, editor, and printer but do not stand out noticeably and do not assist the reader materially. Besides, publications reproduced from typewritten copy by offset process, which are multiplying rapidly and which include both *Bibliography of Agriculture* and *Biological Abstracts*, cannot use boldface type. Roman numerals for volumes, still retained in some conservative publications, most of them foreign, should be abandoned.

Agreement is needed on how to cite the number or part of a periodical when separately paged. The Madison *Rules* provided for writing the separately paged part as a small upper number, such as used in numbering footnotes and variously called a superior figure, index figure, or superscript number. However, superscript numbers have objections similar to those of boldface numerals. I prefer the Department of Agriculture method of citing separately paged numbers or parts in parentheses between volume and colon.

Ordinarily the year of the particular issue is sufficient in citation of the date of a periodical article. The Madison *Rules* recommended that the exact date be given, if possible, with the following abbreviations of months used by the Library Bureau: Ja, F, Mr, Ap, My, Je, Jl, Ag, S, O, N, D. However, the conventional abbreviations of months are clearer to readers, both English-speaking and foreign.

Abbreviation of titles of periodicals. The item in which usage probably varies most widely is abbreviation of titles of periodicals. Fortunately, most shortened titles are readily understood even though inconsistent. A list of these abbreviations was mentioned in the Madison *Rules* but was never published. Agreement on abbreviations is less important than accord upon numerals and typographical devices, and could be considered separately when the rules are revised.

The most detailed reference on this subject is Whitlock's *Abbreviations used in the Department of Agriculture for titles of publications*, issued in 1939 and following earlier lists of 1905 and 1925. It contains a valuable list of abbreviations for single words (pp. 258–278) for preparation of uniform citations of older and newer periodicals and changed titles. Some botanical bibliographies, such as those by S. F. Blake and Alice C. Atwood (*Misc. Publ. U. S. Dept. Agric.*, 1942, **401**, 262) and by Alfred Rehder (*Bibliography of cultivated trees and shrubs.* Jamaica Plain, Mass.: Arnold Arboretum of Harvard University, 1949. Pp. xvii–xxxvii.), have their own special lists of abbreviations of the periodicals cited.

Three arrangements of citation based upon the order of words or abbreviations are used: (1) by strict order of title; (2) by name of institution or society, if a part of title; or (3) by place of institution or society. Thus, *Proceedings of the biological Society of Washington* may be abbreviated: (1) *Proc. Biol. Soc. Wash.*, (2) *Biol. Soc. Wash. Proc.*, or (3) *Wash. Biol. Soc. Proc.*

The first arrangement, with abbreviations in order of title, is the simplest and most widely adopted, being used in *Abbreviations of periodicals cited in the Index to American botanical literature*, by Schwarten and Rickett, and by many botanical periodicals. The Department of Agriculture and *The Agricultural Index* follow essentially the second order. State publications are listed with abbreviation of the state first, publications of the U. S. Department of Agriculture and other departments are under "U. S.," and foreign government publications are entered under names of countries. Advantages for placing institution, society, or state first are that most libraries catalogue periodicals in this manner and that all publications of one organization are listed together.

Many titles, those not containing the name of an institution or society, have the same order under all systems. The second and third arrangements agree with the first for many titles and with each other for most, also. Published lists reveal that slight inconsistencies may occur in any system. None of these arrangements is greatly superior to the others. If agreement upon one is not possible, perhaps the best features of two systems could be combined satisfactorily, or one might be adopted with certain exceptions allowed.

Which words to omit in abbreviations of periodicals is a problem. Rickett (p. 167) stated that "*Bot.*" can be omitted in an exclusively botanical work. Thus, Schwarten and Rickett listed *Bull. Torrey Club* for *Bulletin of the Torrey botanical Club*, *Jour. Wash. Acad.* for *Journal of the Washington Academy of Sciences*, etc. Rather, the question is whether the readers are exclusively botanical. I urge retention of these parts indicating contents, such as "*Bot.*," "*Sci.*," and "*Agr.*," as essential for clarity and for helping nonbotanical readers, students, foreigners, and librarians to find the references.

How much to abbreviate each word is another item in which usage varies too much. For example, *Journal* is reduced to "*Journ.*," "*Jour.*," "*J,*" and "*J.*," and *Bulletin* to "*Bull.*," "*Bul.*," "*B,*" and "*B.*" Rickett (p. 168) has noted that Recommendation XXX of the *International rules of botanical nomenclature*, for abbreviating authors' names, serves admirably for titles.

Possibilities for variation and originality in citing botanical periodicals are almost unlimited. The number of words may vary, their order may be changed, and the abbreviations of words may differ in length. As an illustration, I have found in current usage for *Journal of the Washington Academy of Sciences* eleven different abbreviations. Isn't all this variation rather silly? A partial solution is more one-word periodicals and serials in the future, as discussed by E. D. Merrill (*Brittonia*, 1931, **1**, 1), or even two-word periodicals. A one-name title, such as *Science*, is not abbreviated and cannot be reversed.

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Book Reviews

Human behavior and the principle of least effort: An introduction to human ecology. George Kingsley Zipf. Cambridge, Mass.: Addison-Wesley, 1949. Pp. xi + 573. (Illustrated.) $6.50.

This is one of the most ambitious books ever written. Its expressed purpose is ''to establish the Principle of Least Effort as the primary principle that governs our entire individual and collective behavior of all sorts''; there is an allusion to Hamilton's Principle of Least Action in mechanics. Even more ambitious would be the reviewer who would presume to offer a final appraisal now of the full degree of the book's success. Unquestionably a large part of it will withstand the test of time and will grow in influence, whether or not Least Effort becomes generally accepted as a fundamental coordinating principle of human behavior.

In an age of academic superspecialization, work like this is altogether different and refreshing. It cuts across departmental and divisional boundaries as nothing else has for a century. Language, vocabularies, the ego, sex, schizophrenia, theory of art, human geography, the structure and relations of cities, the incomes and social status of individuals, prestige symbols, and cultural vogues—these are some of the subjects treated with a continuous attempt at closely knit reasoning, modeled in large measure on the reasoning of physical science and at a great many points tested against a wealth of systematic quantitative observations. The extensive recapitulation and bibliography of these alone would make the book a very valuable contribution to empiric social science.

Zipf, unlike most contributors to social studies, is fully aware of the usefulness of empirical mathematical regularities as a stage between observation and theory. Many of the interesting ones cited are his own work or his students'; evidently he possesses the enthusiasm which stimulates volunteers to undertake a long and tiresome count for the sake of establishing some empirical formula which of necessity at that stage completely lacks ''meaning.''

Social statisticians have expended a huge and commendable amount of labor and funds in gathering data, while relatively few investigators have tried to condense these shelves of statistics into roughly approximate empirical rules. Tables or graphs which compare computed with observed quantities are all too rare in the social field. A principal reason seems to be that social scientists are not trained in such work, nor are they readily able to make use of its results. This is because they are accustomed to looking for ''meanings'' intelligible in ordinary human terms and related to general ideas previously advanced.

As one example of detailed data presented (pp. 23–24), the novel *Ulysses*, according to the studies of Hanley and Joos, has 260,430 running words and 29,899 different words. When the latter are listed in the decreasing order of the frequency of their occurrence in the novel, the product of the rank of a word by its frequency roughly approximates 29,000 in every case, throughout the series of 29,899 different words. Of course those at the tail end of the list are used only once apiece, so that the last product is exactly 29,899. To the conventional student of language this empirical rule, rank times frequency equals a constant, is ''meaningless'' and uninteresting.

To an investigator with George Kingsley Zipf's insight and originality this regularity, which he finds repeated again and again in other widely varying data, is surprising and exciting and offers a key to major principles of human activity. He applies it with aid of the concept of ''tools-which-must-match-their-jobs.''

Wisely, or not, the author here and there indulges in satire: some of his remarks about the ''Pied Piper morality'' (pp. 478 f.) are an instance. Galileo was a satirist too; and, while that got him into deeper troubles, perhaps logic needs satire to enliven it when new thoughts are being advanced in the public market.

There are readers who will regret the slow pace of some of the pages, while others will be grateful for the consequent easy steps in the reasoning. It would not be difficult for a commission of experts to comb through this book and suggest minor improvements. It was E. U. Condon, not ''E. V. Condon,'' (p. 546) who made an early suggestion of the rank-times-frequency rule for a vocabulary. Again, (p. 386) Ravenstein's study of migration (1885) is quoted as the pioneer notion of the existence of the formula, population divided by distance. However, Ravenstein did not suspect, as a much earlier writer did, that this formula had general application to the relations of people with people. Henry C. Carey, of Philadelphia, in 1859 gave what he called the ''molecular gravitation'' of people for people, and the activities resulting from their association, leading roles in his three-volume *Principles of social science*. Although his treatment was wholly verbal, it parallels this and other physical formulas mentioned by Zipf.

No reviewer can be a competent substitute for a commission of experts in ''economics, sociology, cultural anthropology, psychology—both general and Freudian—linguistics, and semantics,'' which are relevant fields listed by the author. But the present reviewer is sure he can detect in this book the definitive beginning of a new, less confined, and more humanly productive era in research.

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(Continued from page 651.)

logical and medical sciences would continue at its present level with the indicated redirection of emphasis.

3. Fellows now under appointment are to be candidates for reappointment under the criteria for scientific competence previously applied by the National Research Council, without regard to the additional requirements listed in the previous paragraphs.

4. The National Research Council is to have no responsibility for loyalty determination procedures other than submitting to the Commission the names of fellowship applicants and the names of those applicants judged by the Council to merit fellowships on the basis of scientific promise. Public announcement is to be made that the National Research Council will notify applicants of acceptance or rejection on scientific grounds, and the Commission will notify applicants of acceptance or rejection on grounds of security or loyalty.

It is our opinion that a fellowship program thus reconstituted would make a valuable contribution to the work of the Commission. The administrative experience of the National Research Council, and its established reputation for sound scientific judgment, would guarantee maximum effectiveness of such a program. These arguments have guided us in proposing for your consideration the plan outlined above.

We would like to express to you and to your fellow members of the National Academy of Sciences our gratitude for the attention and study you have given to the fellowship question. It is our sincere wish that an early agreement can be reached.

Letter dated November 30 from Alfred N. Richards, president of the National Academy of Sciences, to Carroll L. Wilson, general manager of the U. S. Atomic Eenergy Commission:

In response to your letter of November 17, amplified by two subsequent memoranda from Dr. Warren, I can now inform you that, should you make the request, the National Academy of Sciences will authorize the National Research Council to administer a new program of AEC fellowships consisting of the following provisions:

1. No new predoctoral fellowships will be offered.

2. In order that commitments in announcements of the predoctoral fellowships and of the postdoctoral medical fellowships for 1949–50 shall be fulfilled, applications for renewal of current fellowships in those categories will be solicited by the National Research Council and renewal recommended for those whose progress warrants it. However, because of the amendment to the Independent Offices Appropriation Act of 1950, such recommendations can become effective only after the applicant has been investigated as to character, associations and loyalty by the Federal Bureau of Investigation and clearance given by the Atomic Energy Commission. Hence those whose applications for renewal are approved by the National Research Council will receive from the Atomic Eenergy Commission a copy of the amendment referred to above and a personnel security questionnaire which must be filled out and returned before the FBI investigation can be initiated. Decisions by AEC, based upon the FBI report, will determine the fellowship awards.

3. The National Research Council will administer a limited program of postdoctoral fellowships in the physical sciences, biology, biophysics and medicine for advanced training in fields of secret work or in problems which require access to restricted data. For holders of these fellowships, FBI investigation and full security clearance constitute an accepted requirement.

In the physical sciences, the fields of study will be limited to those closely related to the AEC program, such as the chemistry and nuclear physics of elements of atomic number greater than 90, the neutron physics of various elements, the effects of high energy radiation on matter, the chemistry of the elements in the fission-products range and the separation of isotopes.

In biology, biophysics, and medicine, the research fields will include experimental aspects related to atomic energy which require the use of the special facilities available in the AEC installations and/or access to restricted data. This work would include studies such as the physiological and toxicological effects of fission products, and the development of radiation instruments as applied to biological and health physics problems of a classified nature.

Since, in this postdoctoral program, considerations of classification policy, security clearance and the AEC program play so great a part, it is deemed inappropriate for the National Research Council to agree permanently to administer it; hence the administrative commitments set forth in this letter do not extend beyond June 30, 1951.

* * * * *

I think you understand that the radical change from the previously existing AEC fellowship program represented by the provisions stated above is the consequence of the belief held by the Council of the National Academy and by the majority of its members who have expressed themselves that FBI investigation of AEC fellows who work in non-classified fields and who do not have access to restricted data is unnecessary from the standpoint of the national security and unwise from the standpoint of the advance of science in the United States.

It is also understood that had the Atomic Energy Commission determined to conduct the administration of a broader fellowship program, the National Academy and the National Research Council would have been glad to assist with scientific advice to the full extent of their competence.

NEWS and Notes

Physicists **Robert J. Oppenheimer** and **Ernest O. Lawrence** and naturalist **Fairfield Osborn** have been appointed to the college of electors of the Hall of Fame for Great Americans on the campus of New York University. Of the 120 Americans now serving on the electoral body, eight are scientists. The new appointees will vote on the 1950 nominees to the Hall of Fame.

The National Institute of Sciences of India has elected as Honorary Fellows **Harlow Shapley,** director of Harvard Observatory, **Louis de Broglie,** French physicist, **Hans van Euler,** Swedish chemist, and **George Tishler,** German botanist.

H. Keefer Hartline, professor of biophysics and chairman of that department at Johns Hopkins University, has been appointed to succeed **Robert D. Fowler** as the scientific representative from Johns Hopkins on the Board of Trustees of Associated Universities, Inc. The board is one of the governing bodies of the Brookhaven National Laboratory.

Manfred Bleuler, director of the Psychiatric Clinic Burgholzli, and professor of psychiatry at the University of Zurich, Switzerland, has joined the staff of the Payne Whitney Psychiatric Clinic, New York Hospital, and will spend a year in research on the etiology of alcoholism. The research project was begun at the clinic three years ago through the support of the National Research Council. Dr. Bleuler has also been appointed lecturer in psychiatry at Cornell University Medical College.

Raymond W. Darland, associate professor of botany, has been appointed head of the Department of Biology of the University of Minnesota, Duluth Branch, succeeding **Olga Lakela,** who will become curator of the university's herbarium.

Hugh McCulloch, chief of the medical staff of LaRabida Jackson Park Sanitarium, Chicago, has been appointed professorial lecturer in pediatrics at the University of Illinois College of Medicine. The college has also announced the appointment of **Sigvald B. Refsum,** who came here recently from Oslo, Norway, as professorial lecturer in psychiatry. Dr. Refsum is conducting research in electroencephalography with Frederic A. Gibbs in the Consultation Clinic for Epilepsy.

S. Kenneth Love, chief of the Quality of Water Branch of the U. S. Geological Survey's Water Resources Division, has been elected chairman of the American Chemical Society's Division of Water, Sewage, and Sanitation Chemistry.

Harold A. Abramson, assistant clinical professor of physiology, Columbia University, has been appointed chief of the Allergy Clinic at the Mount Sinai Hospital, New York City.

Paul Delahay, research associate at the University of Oregon, Eugene, has been appointed assistant professor of chemistry at Louisiana State University, Baton Rouge.

Florence M. MacLean has been appointed clinical director of the Occupational Therapy Section, Department of Physical Medicine, University of Illinois.

John H. Barr, associate professor of medicine, University of Texas School of Dentistry, has been appointed director of clinics and professor of clinical dentistry in the Tufts College Dental School.

Visitors to U. S.

Recent visitors at the National Bureau of Standards included **A. E. Blouin, W. E. Cowie,** and **L. G. Wilson,** of the Defense Research Chemical Laboratory, Defense Research Board, Ottawa; **George Miller,** professor of physics at the National University of Colombia, Bogota; **Roman C. Bieber,** instruments engineer, Lonza, Ltd., Switzerland; and **R. R. Warnecke,** chief, microwave tube research, Compagnie Generale de Telegraphie Sans Fil, Paris.

Fellowships, Scholarships, and Prizes

The National Research Council announces the availability of the Merck Postdoctoral Fellowships for 1950. These fellowships are designed to give special training and experience to young men and women who have demonstrated ability in research in chemical or biological science, and who wish to broaden their fields of investigation. Fellowships are open to citizens of the U. S. with training in chemistry or biology equivalent to that represented by the Ph.D. degree. All fields of chemistry or biology, including the preclinical medical sciences, are open to applicants for these fellowships, and special consideration will be given to applicants who wish to supplement their specialty with work in another field. Applications must be filed before *January 15.* Awards will be made as soon as possible after March 1 and, unless otherwise arranged, tenure will begin on July 1. Appointments will be made for one year; in exceptional cases applications for renewal will be considered. Further information and application blanks may be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

The Society for Pediatric Research has appointed seven additional **Mead Johnson Fellows** for the academic year 1949-50. They are C. T. Lee, China; Solomon A. Kaplan, South Africa; Carlos A. Bauza, Uruguay: Isabelle Valadian, Lebanon; Ramón Sanz Munoz, Mexico; Dacio Pinheiro, Brazil; and Jorge Arguedas Soto, Costa Rica.

The Life Insurance Medical Research Fund invites faculty members to nominate candidates for 1950–51 student fellowships for research in the medical sciences (predoctoral). These fellowships are open to those who will have completed one year or more of work in a medical or graduate school and are in a position to devote at least three-quarters of their time to research. Preference is given to those who wish to work on fundamental problems in cardiovascular function. The usual stipend is at the rate of $1,600 to $2,000 per annum. Candidates must be nominated by investigators who are willing to sponsor them on the basis of personal knowledge. The closing date for 1950 nominations is *February 15*. Further information may be obtained from the Scientific Director of the Fund at 2 East 103d Street, New York City 29.

The Northeastern Section of the American Chemical Society has announced a new award for outstanding achievement in the teaching of chemistry in honor of the late James F. Norris. It was made possible by a bequest of the late Mrs. Anne C. Norris, of Cambridge, Massachusetts, to perpetuate the memory of her husband, who was twice president of the American Chemical Society and a director for eleven years. Teachers from schools, colleges, and universities are eliglible. The award will consist of an inscribed certificate and a sum of money to be awarded biennially, in the years when the Richards Medal for achievement in research is not given by the section.

Summer Studentships and Thesis Fellowships are being offered to qualified graduate students in pure and applied mathematics at the National Bureau of Standards' Institute for Numerical Analysis at the University of California, Los Angeles. The studentships are for a 10-week term from the middle of June to the end of August, with stipends from $500 to $700. The thesis fellowships are fixed at approximately $2,000 for an 11-month working year, provided the candidate already possesses an M.A. degree or equivalent experience. Preliminary applications must be submitted before *March 1*. Further information may be obtained from the director of research of the institute.

The third annual competition of the **Engineering Undergraduate Award and Scholarship Program** has been announced by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. Awards ranging from $1,000 to $25, and $1,750 for seven scholarships will be given to students and schools for the best papers prepared by undergraduates on arc welded design, research, fabrication, or maintenance. Papers must be submitted before *May 15, 1950*. A copy of rules and conditions may be obtained from the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Grants and Awards

Grants for support of medical and biological research totaling $835,770 have been announced by the U. S. Public Health Service. The awards will go to 61 institutions in 29 states, the District of Columbia, and 3 foreign countries and will aid research in a wide range of subjects including nutrition, use of streptomycin in tuberculosis, tropical disease research, electrical activity of the central nervous system, and strains of influenza virus involved in the European epidemic last winter.

Grants to support heart research and to build heart research laboratory facilities have been made to 21 institutions by the National Heart Institute of the National Institutes of Health, Bethesda, Maryland, principal research branch of the Public Health Service. Totaling $358,109, the grants include $248,109 for 20 research investigations in 18 nonfederal institutions in 13 states and the District of Columbia, and $110,000 to provide necessary research laboratory facilities for study of heart diseases in two nonfederal institutions. The largest sum —$100,000—went to the Oklahoma Research Foundation to provide clinical facilities for cardiovascular research in a basic research plant now under construction. Other large grants included $64,800 to Northwestern University for the investigation of rheumatic fever; $38,976 to Western Reserve University, Cleveland, for experimental investigations to improve the circulation of the coronary arteries; and $23,657 to the University of Chicago, for investigating the degenerative complications of diabetes as they affect the arteries.

The American Institute of Chemical Engineers presented the following awards at its annual meeting last week in Pittsburgh: **the William H. Walker Award** for distinctive contribution to the literature of chemical engineering to William H. McAdams, professor of chemical engineering, Massachusetts Institute of Technology for his work in heat transfer; **the Celanese Corporation of America Professional Progress Award in Chemical Engineering** to Mott Souders, Jr., head of the Chemical Engineering Research Section of the Shell Development Company, Emeryville, California.

Nicholas J. Hoff, professor of Aeronautical Engineering at Polytechnic Institute of Brooklyn, has been awarded the **Medal of the Swedish Society of Engineers.** The medal was presented during Dr. Hoff's recent visit to Sweden in appreciation of his contributions to structural engineering, particularly for his work on the instability of airplane fuselages, the buckling of rigid jointed trusses, and the effects of concentrated loads on fuselage frames. Dr. Hoff is the first American aeronautical scientist to receive the medal.

Colleges and Universities

Programs for the spring sessions of the current Mechanics Colloquium at the **Illinios Institute of Technology** are as follows: January 4—"Frontier Problems of Fluid Mechanics" by *H. L. Dryden*, director, National Advisory Committee for Aeronautics; February 1—"The Mechanics of Earth Slides in Clays" by *P. C. Rutledge*, chairman, Department of Civil Engineering, Technological Institute, Northwestern University; March 1—"The Dynamic Behavior of Materials Having Hereditary Characteristics" by *E. Volterra*, associate professor of mechanics, Illinois Institute of Technology (to be held in the Technological Institute, Northwestern University, Evanston); April 5—"Modern Theories of Failure of Materials" by *C. Zener*, professor of physics, Institute for the Study of Metals, University of Chicago; and May 3—"Recent Problems in Vibration" by *J. P. den Hartog*, professor of mechanical engineering, Massachusetts Institute of Technology.

A series of meetings on fundamental problems on growth and malignancy is being presented by the Department of Pathology, **University of Vermont and State Agricultural College**, Burlington, Vermont. Speakers and topics for the forthcoming meetings are: January 5—*Leonell C. Strong*, professor of anatomy, Yale University School of Medicine, "Genetics and Cancer"; February 9—*Albert J. Tannenbaum*, director, Department of Cancer Research, Michael Reese Hospital, Chicago, "Diet and Cancer"; March 2—*Van R. Potter*, professor of oncology, University of Wisconsin Medical School, "Enzymes, Growth, and Cancer"; March 30—*Roy Hertz*, chief, Endocrinology Section, National Cancer Institute, Bethesda, Maryland, "Vitamin-Hormone Interrelationships Affecting Tissue Growth"; and May 4—*Robert E. Stowell*, professor of oncology, University of Kansas School of Medicine, "Nucleoproteins, Growth, and Cancer."

Industrial Laboratories

J. Murray Scott, medical director of Ayerst, McKenna and Harrison, New York and Montreal, has been appointed medical director of **Sharp and Dohme, Inc.**, Philadelphia. Dr. Scott succeeds J. William Crosson, who has been named to fill the newly created position of medical administrator.

The American Optical Company, Southbridge, Massachusetts, has opened its new Stamford Research Laboratory at Stamford, Connecticut. Supplementing the research facilities and program of the company, the laboratory will be used for studies in geometrical optics, microscopy, photographic optics, spectroscopy, optical methods for research in nuclear physics, glass chemistry, instruments, and optical materials.

Meetings and Elections

The 75th Anniversary Meeting of the Cambridge Entomological Club will be held on December 20 at Harvard. The program will include an address by Marston Bates, author of *The natural history of mosquitoes* and member of the staff of the Rockefeller Foundation, on "Entomological Research in the Tropics."

The Relation of Psychology to Medicine will be the subject of a conference to be held at the University of Pittsburgh February 9–10. This is the fourth of the series on current trends in psychology scheduled by the university's Department of Psychology. All members of the American Psychological Association and of the American Medical Association may obtain tickets of admission without charge by writing to the Department of Psychology, University of Pittsburgh.

The Federation of American Societies for Experimental Biology will hold its 34th annual meeting April 17–21, in Atlantic City, New Jersey. Affiliated societies are: The American Physiological Society; American Society of Biological Chemists; American Society for Pharmacology and Experimental Therapeutics; The American Society for Experimental Pathology; American Institute of Nutrition; and The American Association of Immunologists. Approximately 1600 papers will be presented in the fields of these societies. In addition, there will be a joint session of all six societies and several symposia. Attendance will be open to members of the constituent societies and their associates and to interested biologists in all countries.

Biologists in the fields represented by the federation may submit titles and abstracts of papers they wish to read to the secretary of the appropriate society, not later than *January 10*. Nonmembers must be introduced by a member. Scientific and technical exhibits may be made by individuals, laboratories, institutions, and industrial organizations. Further information may be obtained from the Federation Secretary, 2101 Constitution Avenue, Washington 25, D. C.

Scientists from the U. S. and Canada who have been invited to attend the symposium **"Mécanisme de la Narcose"** to be held in Paris April 19–26 are W. D. McElroy, Johns Hopkins University, Baltimore; L. V. Heilbrunn, Zoological Laboratory, Philadelphia; and J. H. Quastel, Biochemical Department, McGill University, Montreal.

The American Chemical Society has chosen N. Howell Furman, Russell Wellman Moore Professor of Chemistry, Princeton University, as president elect; he will head the society in 1951. President for 1950 will be Ernest H. Volwiler, executive vice president of Abbott Laboratories, Chicago, who will take office on January 1, succeeding Linus Pauling, of the California Institute of Technology. The two new members of the Board of Directors, elected to serve three-year terms, are Raymond E. Kirk, head of the Chemistry Department, Polytechnic Institute of Brooklyn, and Farrington Daniels, Chemistry Department, University of Wisconsin.

The Pacific Division of the American Society of Limnology and Oceanography elected the following officers for 1950 at its June meeting with the AAAS in Vancouver, Canada: president, G. F. McEwen, LaJolla, California; vice president, W. T. Edmondson, Seattle, Washington; secretary-treasurer, John P. Tully, Nanaimo, British Columbia; members-at-large, Clifford A. Barnes, University of Washington; and Donald L. McKernan, Clackamas, Oregon.

The American Institute of Chemical Engineers has elected the following officers for 1950: president, Warren L. McCabe, vice president and director of research of the Flintkote Company; vice president, T. H. Chilton, technical director of the Development Engineering Division, E. I. duPont deNemours and Company. S. L. Tyler and C. R. DeLong, both of New York City, were reelected secretary and treasurer respectively.

Deaths

Oliver Edwin Baker, 66, professor of geography at the University of Maryland, died December 2 at his home in College Park, Maryland. Head of the Geography Department since 1942, Dr. Baker had resigned last July in order to devote more time to research. At the time of his death he was working with Charles Hu, of the Geography Department, on an atlas of China and an atlas of world resources.

Charles Kephart Swartz, 88, professor emeritus of geology at Johns Hopkins University since 1931, died November 26 at his home in Baltimore after an illness of several months. As a student at Heidelberg in 1888 he worked with Heinrich Hertz in the early experiments on Hertzian waves. Dr. Swartz was a former president of the American Paleontological Society and former vice president of the Geological Society of America.

George Joseph Brunner, 67, professor of geophysics at Saint Louis University, died November 22. He was an authority on deep earthquakes and his graphical method for determining their characteristics, published in 1943, is widely used.

Charles Robert Moulton, 65, assistant director of the Patent Division of the Argonne National Laboratory since 1946 and former University of Missouri chemistry professor, died in Chicago December 4 of a cerebral hemorrhage.

Walter L. Howard, 77, professor emeritus of pomology at the College of Agriculture of the University of California at Davis, died October 17. Dr. Howard was director at Davis from 1924 to 1937 and in addition to agricultural publications he had written a book about Luther Burbank.

Blindness caused by neutron radiation is being cured in the case of Alexander J. Allen, professor in charge of the University of Pittsburgh cyclotron, whose vision was impaired as he adjusted the cyclotron in the spring of 1948. Almost totally blind, he went last July to Columbia Presbyterian Medical Center in New York City, where Algernon Reese removed the lens of his right eye. Dr. Allen now wears spectacles with a thick right lens. His eye is showing steady improvement. Next summer a similar operation will be performed on his left eye, and it is expected that his sight will be restored.

A new society of industrial microbiologists is to be organized to cover the borderline work in application of microbiological knowledge or processes to work with industrial materials. The society plans to handle such problems as deterioration and preservation of military and industrial materials, microbiologic manufacturing processes, and microbiologic assay. The organization meeting will be held Thursday, December 29 at 4:00 p.m. in the Hotel McAlpin Ballroom, in connection with the New York meeting of the American Association for the Advancement of Science.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago, Illinois, has submitted the following list of wanted chemicals: phloretin; ribose-1-phosphate; 4-bromocyclohexanone; 4-methyl-4-bromocyclohexanone; 4,6-diaminoquinaldine; potassium carbide; 1,7-dibromo-*n*-heptane; 1-methyl-2-methylene-1,2-dihydroquinoline; 6-aminoheptoic acid; 7-aminocaprylic acid; tin carbide; berbamine; indoxylic acid; D-laudanosine; canadine; apiin; 2,3-dimercaptobutane; estriol glucuronate; barbatinic acid; and phrenosin.

A research clinic for multiple sclerosis and related disorders of the nervous system has been established at the Montefiore Hospital, in the Bronx, New York, through a grant from the National Multiple Sclerosis Society.

A training course for cardiovascular investigators, sponsored jointly by the U. S. Public Health Service, American Heart Association, and Western Reserve University School of Medicine, will be offered in the Department of Physiology for the second time, July 1, 1950–June 30, 1951. C. J. Wiggers will be in charge of the course, which will consist of formalized training in cardiovascular research methods, assistance to experienced investigators, supervision of independent research, and practice in manuscript preparation. Postdoctoral candidates accepted for training will be recommended to the director of the National Heart Institute, U. S. Public Health Service, for a research traineeship carrying a stipend ranging from $3,000 to $3,600 per annum. A maximum of ten trainees can be accepted. For information and application blanks, address Dr. C. J. Wiggers, Program Director, Western Reserve University School of Medicine, Cleveland 6, Ohio.

Recently Received—

The Harvard Photographic Meteor Program. Fred L. Whipple. Harvard reprint 319. Harvard Observatory, Cambridge.

Excavations in Northeastern Massachusetts. Ripley P. Bullen. Papers of the Robert S. Peabody Foundation for Archaeology, Vol. 1, No. 3. Phillips Academy, Andover, Massachusetts.

Observations on the Plant Communities at "Bundemar," Trangie District, New South Wales, in relation to Chortoicetes terminifera *(Walk.) and* Austroicetes cruciata *(Sauss.).* L. R. Clark. Bull. 236. Council for Scientific and Industrial Research, Melbourne, Australia.

The Shoulder Architecture of Bears and Other Carnivores. D. Dwight Davis. Fieldiana-Zoology, Vol. 31, No. 34, Chicago Natural History Museum. 25¢.

The Races of the African Wood-Dove Turtur Afer. A. L. Rand Fieldiana-Zoology, Vol. 31, No. 35, Chicago Natural History Museum. 10¢.

Estudio Sobre las Serofosfatasas. I-Fosfatasa Alcalina. Elena Pennini. Mercatali, Publisher, Avenida Acoyte 269, Buenos Aires, Argentina.

Subspecies of the Ridge-Nosed Rattlesnake, Crotalus Willardi. Laurence M. Klauber. (Reprint) San Diego Society of Natural History, San Diego, California.

The Boylston Street Fishweir II: A study of the geology, paleobotany, and biology of a site on Stuart Street in the Back Bay District of Boston, Massachusetts. Elso S. Barghoorn *et al.* Papers of the Robert S. Peabody Foundation for Archaeology, Vol. 4, No. 1. Phillips Academy, Andover, Massachusetts.

The United Nations Scientific Conference for the Conservation and Utilization of Resources

Carl N. Gibboney
Office of International Trade, Department of Commerce, Washington, D. C.

WHEN MORE THAN 600 scientists, economists, private businessmen, and government officials from 50-odd countries of the world met at Lake Success from August 17 to September 6 for the United Nations *Scientific Conference for the* Conservation and Utilization of Resources, it was thought that anything could happen. What did happen was not startling. There were almost no sharp clashes that created ready-made newspaper headlines, for those who took part were not concerned in this meeting with political ideologies. The organization of the conference must be considered a great tribute to the work of the Economic and Social Council of the United Nations, and to its Secretariat.

In opening the conference, Trygve Lie, United Nations Secretary-General, stated:

> Modern science has developed a wide range of new techniques for wresting more wealth from the earth's resources. Their effective application is basic to achieving a world of abundance—a world where the specters of hunger and wastelands will be things of the past.
>
> In particular, the underdeveloped areas of the world can reap the benefits of learning new methods to use their untapped resources and to build up their economies. The conference represents one of the first and most important steps in the program of technical assistance to underdeveloped countries, which the United Nations is undertaking.

What these world authorities talked about had to do with the material things necessary for the survival of man and his attainment of higher levels of living. What was said about the availability of resources was generally reassuring. There are a few materials which are now considered essential but which are believed to be insufficient to meet the world population's increasing demands. The possibility of new discoveries, the availability of substitutes of more plentiful materials, and the possibilities of conservation in use tended to alleviate the worries of those who were inclined to view the situation in great alarm.

The basis for this general optimism was founded upon the ingenuity, resourcefulness, and knowledge with which modern man is developing techniques for the conservation and use of the resources of the world. Reports of the tremendous advances that are being made in the techniques of production, processing, use, and conservation of resources of the world, as documented in the hundreds of scientific papers presented, proved that necessity was creating invention.

Colin Clark of Australia pointed out the race between the increasing world population and the world's food supply:

> While man has proved himself capable of the most appalling misuse of natural resources under certain circumstances, he has also shown himself capable of scientific improvement of agricultural technique capable of raising the product per man-year at the rate of 1½ percent per annum. Even in some of the crowded areas of Europe and Asia great increases in agricultural production have been achieved. The world's population is increasing at the rate of 1 percent per annum and our problem is clearly soluble if we go about it the right way.

A. I. Levorsen of the United States, summarized the outlook for petroleum reserves:

> Petroleum occurs in sedimentary rocks. The volume of sedimentary rocks found both on the land and under the shallow waters of the continental shelf areas bordering the continents may reasonably be expected to contain an amount of petroleum per unit volume comparable to what has been found in the sediments of the explored regions. The present estimates of the amount of the undiscovered reserve are on the order of 500 times the current annual world consumption. Such estimates merely reflect the state of technical development and geological understanding at the time of the estimate. As ideas have developed, estimates have increased and may be expected to continue to increase in the future.
>
> These reserves must be discovered, to be of any use. Their discovery is determined by a combination of technological, economic, and political factors.

It was brought out time and time again that research, both fundamental and applied, must be increased if the demands of the world's increasing population are to be met. It was emphasized that research must include discovery, development, production, and use of resources if supplies of needed materials are to provide a basis for the attainment of higher levels of living. It appeared that the earth's resources and the ingenuity of man can provide an almost unlimited potential for improved living standards for the world's population.

But not all of the discussions painted such a rosy picture. Not all of the skill of the minerals scientist, whether he be geologist, mining engineer, or metallurgist, is being put to use in solving the problems of supplying metals and fuels essential to the attainment of higher levels of living. Only a small proportion of the energy available in the rivers of the world is being harnessed to supply power—power which is necessary if man is to produce the requirements for a more satisfactory life.

Tremendous strides are being made in the techniques of surveying forest reserves, in protecting forests from fire, and in the production and utilization of forest products. At the same time, forest resources continue to be destroyed in large scale through fires, insect ravages, and destructive harvesting methods. Decent housing for much of the world's population can be provided only if forest resources are carefully husbanded and utilized. Good forestry management can also supply paper essential to exchange of information among peoples of the world.

Papers dealing with soil resources brought out the disparity between the methods that have been developed for the production and conservation of soil fertility and the methods that are being used by the many millions of people who are trying to earn a living through cultivating the soil. Not only would these advanced techniques conserve the soil's fertility; they would even increase its productive capacity. If properly applied, this improved use of the soil, coupled with advancements in crop production and animal husbandry, could provide the necessary food and fibers to raise living standards for the world's increasing population.

It was also made clear that man need not look to the land alone for his requirements, for in the large part of the world's surface covered by the sea lie great potentialities for the production of food and other necessities. Yet today large populations are sorely undernourished while great unused quantities of fish are near by. In other parts of the world, marine resources are being destroyed by overexploitation.

The experts were in general agreement that, under most circumstances, it would be necessary to apply a combination of techniques involving a number of associated resources if such resources were to be conserved and used for the benefit of mankind. This principle seems to be true whether it is applied to a river valley or to the economy of a whole country or region. An example brought this out. Scarcity of fuel in one area had resulted in denuding the productive land of trees and shrubs that had protected it from desert encroachment. Hence, in this instance, the saving of productive soil became a question of finding an alternative fuel supply.

Thoroughgoing surveys and analyses are needed as a basis for planning resource developments. Without adequate surveys, a single resource may be developed for only one purpose, when further study may indicate that a number of purposes could be served by a single development. For example, in the rush of industrializing underdeveloped countries, a river may be dammed for power purposes without study of irrigation and flood control possibilities. In other instances, the conservation of soil fertility may be handicapped because of the lack of phosphates. Surveys may reveal that phosphate production must await development of transportation and power. Combined resource development was considered to be of particular importance in the underdeveloped countries.

Even though it was already agreed that this comprehensive approach is essential, the conference participants were unable to agree how a combined resource technique could best be applied in an underdeveloped country where technicians, skilled labor, and capital are limited. Roberto Vergara of Chile threw light upon the subject.

> A people must be considered the very first resource in any undertaking into industrialization. The structure of business and of government, the financial and political situation, and willingness or ability to carry forth programmes of development are the foundations of plans and statistics.

The importance of metal production and consumption to the attainment of high levels of living was examined. Howard A. Meyerhoff of the United States pointed out that:

> The rapid increase in the volume of metal production since 1914 has tempted experts to correlate metallic output and living standards. Upon analysis it is found that the correlation factor is low if based on production, and only moderately higher if based on consumption. Living standards depend upon productivity, which is a function of integrated regional economies. The natural or geographic regions that comprise the earth's economic units are unrelated to political boundaries, and integration is seriously impaired by artificial restrictions imposed by nationalistic interests. The expanding geography of metal supply demonstrates the international, rather than national, character of the world's economy; and if the production, processing, and utilization of metals are to make their proper contribution to improvements in living standards, there must be regulated but unrestricted exploration, exploitation, and movement of all essential raw materials and of the manufactured goods that foster higher productivity and create exchange.

It was found by comparison that there was wide variation between the levels of living attained by workers engaged in similar aspects of metal production in different regions of the world. Of the countries whose economies are based almost wholly on agriculture, not all can be characterized by a low standard of living. A high standard of living is dependent upon productivity rather than the presence of particular resources or combinations of resources in a political subdivision of the world.

The caloric content of a population's diet was thought to be a more realistic measure of the level of living than the per capita consumption of metals. Consequently, it appeared that present trends in some countries to develop a "well-rounded" economy by insisting upon developing mineral industries without adequate mineral resources were unsound. Proponents of industrial production have failed sometimes to understand that it is high productivity and not necessarily diversification of industries that creates the basis for high levels of living.

United States Secretary of the Interior J. A. Krug called attention to the fact that:

> . . . the peoples of the world want help in turning their best dreams into reality. There is demand everywhere for a fair chance to share in the opportunities which the world's scientists have opened up. People in the remotest hills and deserts have glimpsed the possibility of shifting some of their century-old, backbreaking labor over to machines and they are formulating the goals of a higher standard of living, of better education for their children, of a life that contains some leisure, pleasure, and promise.
>
> None of us should underrate the force of this great popular longing. It is one of the major facts of this century. It crosses national boundaries. It pervades groups in all communities. It is dynamic. It pushes organizations and governments into action.

The techniques discussed, if applied to the problems of populations of underdeveloped countries, would greatly increase the level of economic activities which would support higher levels of living. However, the obstacles to the application of a particular technique in these circumstances were considered to be very great indeed. For example, a very high per cent of the total population in many underdeveloped countries is engaged in what is known as "subsistence agriculture." This population is made up of families which produce their own food, clothing, and shelter but which either have no surplus for sale or have a surplus for which no markets are available because of lack of transportation or other reasons. In many cases such families are not producing enough food for themselves. With commercial fertilizers they could produce more food but even if they were able to produce more than they needed it could not be sold until marketing facilities were developed. Consequently, these families would have no money to pay for the increased fertilizer.

The scientists struggled with the problem of breaking into this vicious circle and were unable to find any solution that could be readily applied. But they did throw a great deal of light upon the nature of the problem. In most cases the amount of arable land per family is too small to yield surpluses to pay for fertilizer and other requirements for increased productivity and higher levels of living. Poor health, caused by malnutrition, improper sanitation, and other dangerous hygienic conditions, results in lack of energy—another segment of a vicious circle.

Experts at the conference who have worked in widely dispersed areas of the world firmly believe that the application of scientific techniques to primitive conditions can benefit not only the populations concerned but the whole world economy. However, they also agree that scientific techniques must be adapted to meet the physical conditions in a particular locality and must be presented to the populations concerned in such a way that the techniques will not only be understood but will be accepted. It was repeatedly said that a beginning must be made where the people are.

A representative from Israel, in commenting upon the prevalence of illiteracy throughout populations of the world, suggested that the beginning of the application of scientific techniques had to be made in teaching the populations to read and write. The transmission of new ideas is almost impossible, or at least greatly impeded, if the recipients of valuable information are unable to read or write. In making this statement, this conference participant was saying the same thing that others had said in different words—that the hope for the conservation and wise use of the world's resources is dependent upon the rapidity with which educational opportunities are extended throughout the world.

To some attending the conference it seemed surprising that scientists who would come to the conference to discuss purely technical subjects dealing with physical resources were interested in the discussions that dealt largely with the education of illiterate people. But as the discussions proceeded it became clear that ignorance was resulting in permanent loss of world resources, was retarding the demands for industrial products, and was preventing the development of a skilled labor force, which is essential to industrial production. It was clear that the rivers can be harnessed to produce power for industry. But unless there is available a skilled labor force to combine the power thus produced with the raw materials of the area, the production of the power is not economical. Further, if needed products are produced but cannot be marketed because the population lacks buying power their production is unprofitable.

In addition to defining some of the common denominators of economic development many corollary benefits were derived from the conference. The world's leaders in resource development became better acquainted. Frank and open discussion was possible. Time was not wasted in quibbling over words but was put to use in weighing ideas. The proceedings of the conference, to be published in a number of languages, will become a lasting source of technical information and practical ideas for applying scientific techniques toward world-wide resource conservation and use.

Although this conference was called long before President Truman's inaugural address, in which he proposed "a bold new program" for the development of the world's resources, especially in underdeveloped countries, it came at a particularly advantageous time—when the nations of the world are considering how to carry out such a program.

Age Determinations by Radiocarbon Content: Checks with Samples of Known Age

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FURTHER TESTS of the radiocarbon method of age determination (*1–3, 6, 8, 10*) for archaeological and geological samples have been completed. All the samples used were wood dated quite accurately by accepted methods. The measurement technique consisted in the combustion of about 1 ounce of wood, the collection of the carbon dioxide, its reduction to elementary carbon with hot magnesium metal, and the measurement of 8 grams of this carbon spread uniformly over the 400-square-centimeter surface of the sample cylinder in a screen wall counter (*7, 9*). The background count was reduced during the latter part of the work to 7.5 counts per minute (cpm), which is some 2 percent of the unshielded background, by the use of 4 inches of iron inside 2 inches of lead shielding, plus 11 anticoincidence counters 2 inches in diameter and 18 inches long, placed symmetrically around the working screen wall counter inside the shielding. The screen wall counter had a sensitive portion 8 inches in length, so the long anticoincidence shielding counters afforded considerable protection on the ends. No end counters were used. The data obtained are presented in Table 1 and Fig. 1.

TABLE 1

AGE DETERMINATIONS ON SAMPLES OF KNOWN AGE

Sample	Specific activity (cpm/g of carbon)		Age (years)	
	Found	Expected	Found	Expected
Tree Ring	11.10 ± 0.31 11.52 ± 0.35 11.84 ± 0.25 10.15 ± 0.44 11.08 ± 0.31 Average: 10.99 ± 0.15	10.65	1100 ± 150	1372 ± 50 (577 ± 50 A.D.)
Ptolemy	9.5 ± 0.45	9.67	2300 ± 450	2149 ± 150 (200 ± 150 B.C.)
Tayinat	8.97 ± 0.31 9.08 ± 0.30 9.58 ± 0.32 Average: 9.18 ± 0.18	9.10	2600 ± 150	2624 ± 50 (675 ± 50 B.C.)
Redwood	8.81 ± 0.26 8.56 ± 0.22 Average: 8.68 ± 0.17	8.78	3005 ± 165	2928 ± 52 (979 ± 52 B.C.)
Sesostris	7.73 ± 0.36 8.21 ± 0.50 Average: 7.97 ± 0.30	7.90	3700 ± 400	3792 ± 50 (1843 ± 50 B.C.)
Zoser: Sneferu		7.15	4750 ± 250	
Zoser	7.88 ± 0.74 7.36 ± 0.53			4650 ± 75 (2700 ± 75 B.C.)
Sneferu	6.95 ± 0.40 7.42 ± 0.38 6.26 ± 0.41 Average: 7.04 ± 0.20			4575 ± 75 (2625 ± 75 B.C.) Average: 4600 ± 75 (2650 ± 75 B.C.)

The youngest sample used was furnished by Terah L. Smiley, of the University of Arizona Laboratory of Tree-Ring Research. It was a sample of Douglas fir excavated by Morris in the Red Rock Valley in 1931, the exact location being Room 6 of the Broken Flute Cave. The inner ring date is 530 A.D. and the cutting date is 623 A.D.

The next sample was furnished by John Wilson, of the Oriental Institute at the University of Chicago, and was a piece of wood from a mummiform coffin

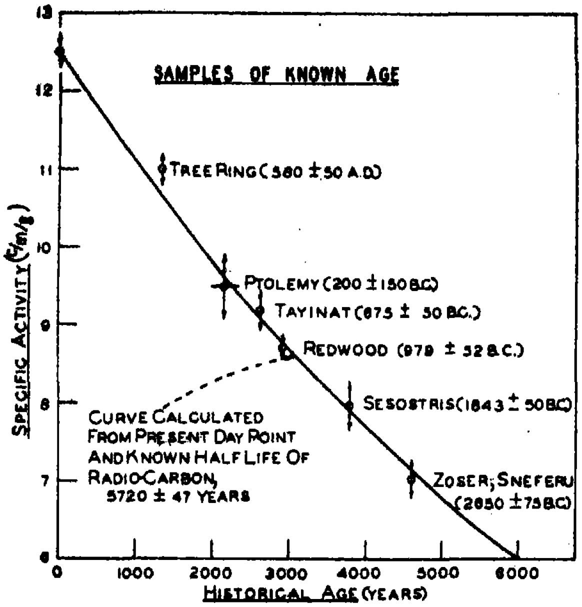

FIG. 1. Specific activities for samples of known age.

from Egypt, dated on stylistic grounds in the Ptolemaic period 332–30 B.C. It was measured quite early in our research, when the sensitivity of the instrument was somewhat less, and so the error is larger and only one measurement was made.

The next sample was furnished by Robert Braidwood, of the Oriental Institute, and consisted of two fragments of wood (*Pinus halepensis*) from the floor of a central room in a large *hilani* (palace) of the Syro-Hittite period in northwestern Syria. Prof. Braidwood dated the material between 725 and 625 B.C. from an imported Corinthian alabastron fragment, together with a great deal of historical evidence. This sample was measured with considerable care and with our most sensitive instrument. The agreement seems to be satisfactory.

The redwood sample was furnished by Edmund Schulman, of the Laboratory of Tree-Ring Research at the University of Arizona. It was a fragment of the inner part of a *Sequoia gigantea* tree felled in 1874 A.D. It is known as the Centennial Stump and has been described by A. E. Douglass (*4*). The sample furnished carried a sequence of rings from 1031 to 928 B.C.

The fifth sample was a piece of deck board from the funerary boat of the Egyptian Sesostris III, which is displayed in the Chicago Natural History Museum. The wood probably is cedar of Lebanon. The sample was kindly furnished to us by the museum through the good offices of C. C. Gregg and Alex Spoehr. John Wilson dated the material as 1843 ± 50 B.C.

The last sample, really being two samples, was described, with measurements, in an earlier publication (*10*). One of the two was from the tomb of Sneferu of Meydum (furnished by Froelich Rainey, of the University of Pennsylvania Museum in Philadelphia), which was 4575 ± 75 years old. The other was from the tomb of Zoser at Sakkara (furnished by Ambrose Lansing, of the Metropolitan Museum in New York City), which was 4650 ± 75 years old. The former sample was cypress wood and the latter acacia. The dates were given by John Wilson.

The agreement between prediction and observation is seen to be satisfactory. The errors quoted for the specific activity measurements are standard deviations as computed from the Poisson statistics of counting random events. One of the six average values, and seven of the 17 individual runs, differ by more than one standard deviation unit from the predicted value. Since in a long series of measurements 32 percent may be expected to fall outside this limit, we may conclude that the statistical error is the major source of scatter. Thus the deviation in the Douglas fir tree-ring sample should not be considered significant.

The errors quoted in the column "Age (years)" of Table 1 include also the uncertainties in the (relative) value of the present-day specific activity, and in the value of the half-life of C^{14}.

At intervals throughout the work, samples of anthracite coal were measured and no significant radioactivity was ever found. This served as a check on possible sources of contamination in the course of the measurement, such as chemicals used in processing, and the necessary exposure to air during the handling of the material.

These results indicate that the two basic assumptions of the radiocarbon age determination method—namely, the constancy of the cosmic radiation intensity and the possibility of obtaining unaltered samples—are probably justified for wood up to 4600 years. The fact that the most ancient samples agree with the predicted value shows that the cosmic ray intensity has been constant to within about 10 percent for periods up to 20,000 years ago. This refers to variations over intervals comparable with the half-life of radiocarbon, 5720 ± 47 years (*5*); it is obvious that shorter time variations would average out and would not affect the measurements.

The *Sequoia gigantea* sample has an additional interest of its own in that the wood spent most of its time at the heart of a live tree, and if any chemical processes had occurred involving the inner heartwood the specific radioactivity would have been elevated above the value found. In other words, this check apparently shows that the redwood heartwood is truly dead and does not partake in any of the metabolic processes of the tree. This finding is not surprising to most botanists.

These results seem sufficiently encouraging to warrant further investigation and application of the method. We have been assisted in this work from the beginning by a committee of the American Anthropological Association and the Geological Society of America, consisting of Frederick Johnson, chairman, Donald Collier, Richard Foster Flint, and Froelich Rainey. This committee advised us what samples of known age to use for testing and greatly assisted us in procuring them. The attempt to establish the method for the great unknown periods of prehistory has involved further work with this committee and the majority of our decisions and efforts to date on unknown samples have been directly connected with their efforts. It was decided that the proof of the method in periods older than 5000 years, for which there are no generally accepted dates for testing, would have to be obtained by checks of internal consistency from a wide variety of samples and in a wide variety of problems. Eleven different major dating questions were selected for this purpose and prominent investigators in each case were invited to collaborate in the research. The problems selected were: Early Man, with Frank H. H. Roberts, Jr.; California–Oregon, with Robert Heizer; Hopewell–Adena, with James Griffin; Mankato, with Richard Foster Flint; Mesopotamia and Western Asia, with Robert Braidwood; Peru, with Junius Bird; Scandinavia and Western Europe, with Hallam Movius; the Southeast, with William S. Webb; the Yukon, with Frederick Johnson; the Valley of Mexico and Tepexpan Man, with Helmut de Terra; and Pollen Chronology, with Edward Deevey.

It is hoped that investigators who have samples fitting into these general problems will write to the collaborators named, to the committee, or to the authors, so that the best materials available can be used for the research. The samples may consist of wood, charcoal, peat, cloth, flesh, and possibly antler, teeth, and shell. Since ten grams of carbon is needed for a single measurement and at least two independent measurements should be made on each sample, some two ounces of wood or charcoal and correspondingly larger quantities of the other materials, according to their carbon content, are needed. In important cases, where only smaller amounts can be furnished, measurements can be made at some sacrifice of accuracy.

The authors are extremely grateful to E. C. Anderson, whose contributions to the development of the technique of measurement were very great. Also, thanks are due Robert Merrill and Richard Wolfgang for assisting in the measurements. The research has been and is now supported in large part by a grant from the Viking Fund, Inc., of New York City. It is hoped that during the next year a decisive test of the method for the prehistoric periods up to 20,000 years will be obtained through the investigations described.

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TECHNICAL PAPERS

An Inverse Decibel Log Frequency Method for Determination of the Transfer Functions of Psychobiological Systems[1]

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In previous papers, the writer has proposed the concept of transfer function for representing psychological and biological systems, in a manner analogous to its use for representing linear physical systems, such as servosystems and electrical networks (*9, 12*). It was pointed out that such transfer functions could, in principle, be derived on a purely empirical basis, in view of the fact that a one-to-one correspondence exists between the transfer function of a linear system and its response to specific input functions. The present paper describes a method by means of which the transfer functions of lumped constant linear systems can be derived from experimentally determined frequency response curves. Although developed primarily for use in deriving the transfer functions of the response systems of living organisms, it is applicable to any system that can be regarded to a first approximation as a lumped constant linear system, without regard to the type of components of which it is made up, whether living or nonliving.[2]

The method to be described rests on concepts and procedures involved in the so-called decibel (db) log frequency method developed for analysis and synthesis of servosystems and analogous networks. This latter method is hereafter referred to as the direct db-log frequency method in contrast to the method to be described in the present paper, which we designate as an inverse db-log frequency method.

As the names imply, the goals and procedures in the two methods are opposite to each other. In the direct method, an analytical transfer function, like that shown in equation (1), is given, and the problem is to plot the gain and phase frequency response curves corresponding to this function. In the inverse method a gain-frequency response curve (experimentally determined) is given, and the problem is to derive the analytic transfer function represented by this curve.[3] This latter procedure is equivalent to finding the differential equation representing a system from the specification of the solutions of the equation for a particular set of input functions.

$$P(s) = \frac{30s + 10}{2s^3 + 4.5s^2 + s} \qquad (1)$$

As a preliminary to the description of the inverse method, a number of the terms and procedures involved in the direct db-log frequency method should be clarified—namely, transfer function, asymptotic frequency response curve, exact frequency response curve, and the db corrections which must be made for points in the asymptotic curve to derive the exact curve. For a fuller description of the direct method and discussion of these concepts, reference should be made to recently published expositions of servotheory (*2, 5, 6, 7, 8*).

A key concept is that of transfer function. It is a mathematical function representing the properties of a given system. The standard way of deriving it is to write the differential equation of the system, convert it to operational form through the application of the Laplace transformation or an equivalent procedure, and then find, by elementary algebraic operations, the ratio of the output to the input functions (*8*). Examples, in factored form, and with nondimensional parameters, are given in equations (2) and (3). Equation (3) is derived from Equation (2) by substituting $j\omega$ for the complex variable s. The transfer function, as given on the right-hand side of each of these equations, contains only the independent variable s (or $j\omega$), and time constants such as T_1, T_2, . . . T_k, . . . T_n, representative of the components of the system and their organization. The transfer function thus provides a compact representation of the system itself, and a means for predicting the response of the system to any arbitrary input disturbance or stimulus (*4, 8*).

$$\frac{Y(s)}{X(s)} = K \frac{(T_2 s + 1)}{s(T_1 s + 1)\,(T_3 s + 1)} \qquad (2)$$

$$\frac{Y(j\omega)}{X(j\omega)} = K \frac{(j\omega T_2 + 1)}{(j\omega)\,(j\omega T_1 + 1)\,(j\omega T_3 + 1)} \qquad (3)$$

In plotting frequency response curves by means of the direct db-log frequency method, three steps are involved: formulation of the transfer function in factored form (equations 2 and 3), construction of an asymptotic db-log frequency curve made up of straight line segments, and construction of an exact db-log frequency curve on the basis of corrections made in the asymptotic curve.[4]

In the factored form of the frequency transfer function

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[1] The research program of which this study is a part was aided by a grant from the Penrose Fund of The American Philosophical Society.

[2] A lumped constant linear system may be defined as one that can be described by a linear differential equation with constant coefficients.

[3] The method described here relates only to the gain-frequency curve and not to the phase curve. In a minimum phase system, the phase curve can be derived from the gain curve (*1*). A number of alternative terms have been used in place of gain, such as amplitude and modulus. Thus the db-log frequency method has also been called the log modulus method (*2*). A gain curve, measured in db units and with a change in sign, may also be referred to as a loss or attenuation curve.

[4] The term *frequency*, as used in this paper, is taken to mean the angular frequency ω, measured in radians per sec. It is equal to $2\pi f$, where f is measured in cycles per sec.

(equation 3), factors of the following three types may occur: $(j\omega)$, $(j\omega T_k+1)$, and $(j^2\omega^2T_q^2+j\omega 2\zeta T_q+1)$, the last being a quadratic factor which equals the product of two single order factors with conjugate complex roots. Each of the various types of factor may appear in numerator or denominator and with integral exponents equal to or greater than one. There can be only one of the $(j\omega)$ terms present, but any number of the other two types of factor. *The single order time-constant factors differ from each other only in the value of the time constant* T_k.

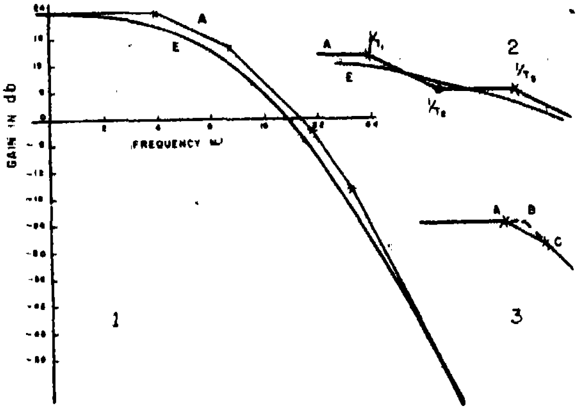
The straight line segments of which the asymptotic curve is composed all exhibit slopes of some multiple of 6 db per octave. The points at which they intersect are referred to as corner points or break points. There is one such corner point for each time-constant factor in the transfer function, the frequency coordinate of the corner point being equal to the inverse of the corresponding time-constant, e.g., $1/T_1$, $1/T_2$, and so on.

In one procedure for constructing the asymptotic frequency curve from the transfer function, one starts at the low frequency end with a line coincident with the 0 db axis, and continues it until the first corner point, located at ω equal to $1/T_1$, corresponding to the largest time constant. A second straight line segment is drawn from here to the next corner point, located at ω equal to $1/T_2$, *T_2 being the next largest time constant, and so on.* At each successive break, the following segment is drawn with a slope differing from the previous segment by $6n$ db per octave, where n is the exponent of the time-constant factor represented. The sign of the increment in slope is negative for factors in the denominator and positive for factors in the numerator. If there is a $(j\omega)$ term in the transfer function, the initial straight line segment has a slope of plus or minus $6m$ db per octave instead of 0 db per octave, where m equals the order or exponent of the $(j\omega)$ factor; and the slope is *negative if the factor is in the denominator.* This asymptotic plot is of great importance in connection with our present problem, since it places in evidence, at the various corner points, the values of the time constants which characterize a given transfer function.

An additional set of relations that we shall need to utilize in our inverse method relates to the db corrections (ε) that must be made at each corner point in the asymptotic curve in order to find the corresponding point on the exact frequency curve. The total correction at any value of ω equals the algebraic sum of the corrections due to *each* time-constant factor in the transfer function. The magnitude of the correction *for each factor* is given by equation (4). This quantity should be added to the asymptotic curve at any value of ω to obtain the corresponding point on the exact curve. Its sign is negative for factors in the denominator and positive for factors in the numerator. The smaller the interval between ω and $1/T_k$ *on a logarithmic scale, the greater is the correction required for the factor containing* T_k. Hence, if a set of corner points are densely distributed on the log ω axis, the net correction at the various corner points will be correspondingly high.

$$
\begin{aligned}
|\varepsilon| &= 10\ \log_{10}(\omega^2T_k^2+1),\ \text{for}\ \omega T_k \leqq 1 \\
&= 10\ \log_{10}(\omega^2T_k^2+1)-20\ \log_{10}\omega T_k,\ \text{for}\ \omega T_k \geqq 1
\end{aligned}
\tag{4}
$$

We may now consider the inverse method. Its design and the justification for the various steps proposed rest on the following set of principles. The over-all *asymptotic* curve of any transfer function is the algebraic sum of the asymptotic curves representing each of the component factors in the transfer function, due to the fact that these curves are logarithmic plots (in db) of the factors in the transfer function.[5] Similarly, the over-all exact db-log frequency curve is the sum of the exact curves of each of the components. Hence the total or net correction representing the difference between the over-all exact curve and the over-all asymptotic curve will equal the sum of the correction curves for each of the components.[6] Our aim has been, therefore, to find a way of determining the total correction curve (or appropriate *points on it*), *and to subtract it from the experimentally* obtained exact frequency curve. This procedure, if accurate, will lead to the asymptotic curve and thus reveal, by way of the corner points, the values of the time constants of the system.



FIGS. 1, 2, and 3. 1—Relation of asymptotic (A) and experimental (E) frequency curves corresponding to a transfer function with only real poles. 2—Relation of asymptotic and experimental frequency curves corresponding to a zero lying between two poles in frequency. (Location of poles indicated by ×, zeros by ●.) 3—Procedure for finding approximate location of a second order corner point (B) from two single order corner points close together (A and C).

To illustrate the procedure in detail, let us consider the frequency response curve that corresponds to a transfer function with only real poles. That is to say, the factors of the transfer function are all assumed to lie in the denominator, and there are no quadratics. The frequency response curve of this function will show a continually

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[5] The asymptotic curve for any single time-constant factor consists of only two straight lines, one asymptotic to the low ω end and the other to the high ω end of the exact curve. The term *asymptotic* is retained for the over-all curve obtained by taking the sum of the component curves, even though, in the over-all curve, only the first and last segments are asymptotic to the over-all exact curve.

[6] This correction curve is the same for all time-constant factors if the correction is taken as a function of ωT_k, where T_k is any time constant.

increasing slope, as in curve E of Fig. 1. Let us suppose that this curve, plotted ω db-log on scales, has been experimentally determined, and our problem is to determine the transfer function to which it corresponds. Such an experimental curve, equivalent to the "exact" curves of our previous discussion, is not made up of straight line segments and shows no directly perceptible features that identify the factors of the transfer function. If, however, we can derive from it the corresponding asymptotic curve, the corner points of the latter and the slopes of adjacent segments will provide us with the necessary information.

The procedure proposed may be regarded as a graphical method of successive approximation, carried out in a series of stages. As a preliminary step, the asymptotes are drawn to the low and high ω ends of the curve, using straight lines with slopes that are some multiple of 6 db per octave. At the low ω end this is likely to be a line with a slope equal to zero or -6 per octave. The first step of stage one consists in finding a trial set of corner points. As a basis, it is assumed that the db correction (ε) at each corner point will be 3 db. This assumption represents a limiting condition, and is accurate only for a single time-constant factor or for transfer functions with widely separated corner points (e.g., at intervals greater than about 3 octaves). The assumption is useful, however, as a starting point in the series of successive approximations.

To locate the corner points, a pair of dividers is set at the 3-db separation, and moved along the low frequency asymptote, toward the higher frequencies, until the point on this line is found which is 3 db distant, along an ordinate, from the experimental curve. This point is the first trial corner point. A second straight line is drawn from this point, with an increment in slope of -6 db per octave. The first point on this line that differs from the exact curve by 3 db gives the second corner point. The procedure is continued until one of the straight line segments intersects the high frequency asymptote, giving the final corner point. The total number of corner points associated with the curve should be equal to or greater than the difference between the slopes of the final and initial asymptotes, measured in db per octave, and divided by 6. (In a frequency curve with inflections, there are an additional number of corners equal at least to number of inflections.) It is frequently more effective, in locating the corner points, to work alternately from the low and high ω ends until an intersection of straight line segments occurs in about the middle of the frequency range.

This initial set of corner points provides an approximation to the density of the correct distribution of corner points. This initial set can now be used as a basis for obtaining a more accurate estimate of the db correction at each of the corners. This computation is carried out in the standard way described for the direct db-log frequency method, and indicated above (*2*, *7*, *8*). A table giving corrections for various values of $\omega/1/T$ or ωT can be used to accelerate the process.

The second stage of the approximation can now be carried out in a manner similar to that described. A second set of trial corner points is determined by using as db corrections (in the locating of successive corners) the values just computed instead of the initially assumed 3-db values. This new distribution of corner points is then used in the calculation of a second set of correction values. The procedure can be repeated until the shifts in location of the corner points with each new stage becomes less than some previously established criterion. A more basic test can be made by using the direct method to plot an exact "theoretical" curve from the final set of corner points, and comparing this theoretical curve with the experimentally given curve. If the agreement between the two is not considered satisfactory, the inverse process of successive approximation can be carried further.

The procedure described was adapted to a frequency curve with a progressively increasing slope up to the final asymptote. The result will be a transfer function containing only single order factors in the denominator. Some adjustment in procedure is needed for curves that may differ from this pattern. These modifications can be described briefly by reference to the factors in the transfer function to which they correspond.

In considering the significance of factors in the numerator of transfer functions, the following terms used in complex function theory will be found convenient. The zeros of a function are the roots of the factors in the numerator; the poles are the roots of factors in the denominator. A transfer function with a zero intermediate in frequency between that of two poles will be represented by a frequency diagram such as that of Fig. 2. Corresponding to a zero represented at ω equal to $1/T_2$ there is a reversal in the sign of the increment in slope of the following segment; corresponding to a pole at ω equal to $1/T_3$ there is another reversal in the sign of the slope increment. At frequencies just below those at which these reversals in sign take place, we note that the exact curve intersects the asymptotic curve. This relationship suggests the following rule for incorporation in the inverse method. Whenever a given segment of the trial asymptotic curve crosses the experimental curve, the following segment should be drawn with a reversal in the sign of the slope increment of 6 db per octave. The effect of the rule is to keep the asymptotic curve from deviating too far from the experimental curve.

The possibility of higher order factors is most easily handled by regarding each such factor as equivalent to a product of the appropriate number of single order factors. The presence of such higher order factors will therefore tend to give rise, in the inverse method, to the determination of corner points very close together. If this situation occurs, one may try the effect of substituting a second order or double corner point, as at B, for two single order corner points, as at A and C of Fig. 3. The manner of locating B by extending the previously found straight line segments until they intersect at B is indicated by the figure. The substitution of B for A and C eliminates segment AC as part of the asymptotic curve and implies a second-degree factor in the transfer function in place of two single-degree factors. The final test of whether the substitution is desirable will be the agreement obtained between the original experimental frequency curve and the theoretical frequency curve corresponding to a given set of corner points.

Finally, a word must be added concerning the procedure necessary for handling possible quadratic factors in the transfer function. A fuller discussion of means for experimentally detecting such factors in the experimental system is reserved for a later paper. One possible approach may be indicated. The presence of a quadratic factor can be detected by observing or recording the transient response of a given system to a step function. Quadratic factors, corresponding to conjugate complex roots, reveal themselves in the transient by damped oscillations. If these can be measured with sufficient accuracy, the damping ratio ζ, and the time constant T_q, can be identified (*2*, *7*, *8*). The specific db-log frequency curve corresponding to a quadratic with the given ζ and T_q can then be determined by computation, or taken from a chart of nondimensional quadratic frequency curves (*7*). The total curve corresponding to the quadratic can then be subtracted graphically from the over-all frequency response curve, leaving a residual curve devoid of the influence of quadratic factors. The inverse method described above may then be applied.[7]

Once the asymptotic curve has been determined, the process of writing the corresponding transfer function is relatively simple. The frequencies of the various corner points are written along the ω axis in the form $1/T_k$. One now proceeds from the low frequency end of the graph, writing down factors to correspond to successive segments. An initial segment at a slope of 6 m db per octave implies a $(j\omega)$ factor with an exponent equal to m. It is located in the denominator if the slope is negative and in the numerator if it is positive. A time constant factor $(j\omega T_k + 1)^n$ is written for each successive corner point, with the appropriate value of T inserted in the factor. The degree of the factor equals n, where the increment in slope of the segment following the corner point is 6n db per octave. If the increment in slope is negative, the factor goes into the denominator; if positive it goes into the numerator. In case a quadratic wave-form has been initially subtracted from any part of the experimental frequency curve, a corresponding factor, $(j^2\omega^2 T_q^2 + j\omega 2\zeta T_q + 1)$, is inserted in the transfer function, with numerical values for T_q and ζ. A function constructed in the manner described represents the frequency-dependent part of the total transfer function, and may be designated as the function $G(j\omega)$, in the terminology of servotheory. It can be converted into the more general function $G(s)$ by substituting the complex variable s for $j\omega$ in all factors of the transfer function (*4*, *6*, *8*).

The magnitude of the constant gain coefficient K can be determined by inspection of the initial (low ω) segment of the asymptotic curve (*7*, *8*). Its height above the zero db axis (given in db units, and converted into units of gain), at ω equal to one, gives the value of K. The final transfer function, $KG(s)$, thus derived from the experimentally given frequency curve, will be in factored, nondimensional form. From this form it can be readily converted to nonfactored form by multiplying out the various factors; and can then be reformulated as a differential equation (*8*, p. 238). In either form, it can serve as a compact representation of the system, and as a basis for predicting its response to any arbitrary disturbance.

[7] A general estimate of the accuracy attainable with the inverse method, for all types of experimental frequency curves, is not as yet available. For the frequency curves with which it has been tried thus far, curves corresponding to transfer functions with four or five poles and zeros, it was found possible to determine correctly the number and location of factors, in numerator or denominator, and the frequency coordinate of the corner points, with errors of the order of 10% after three or four stages of approximation.

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Some New Finds of Fossil Ganoids in the Virginia Triassic[1]

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Leesburg, Virginia

In the course of an extensive study of the carbonaceous and bituminous sediments of the Triassic basins in Virginia, a number of heretofore unrecorded fossil fish localities were discovered and investigated.

In October 1942 Martin examined a fresh roadcut along State Route 55 near Thoroughfare Gap in Prince William County and discovered a heretofore unknown or unmapped extension of the nearest Triassic basin (*1*). Along the base of the cut the imprint of a ganoid about 6 in. long, including most of the head and forward fins, was found in an exposure of very soft and moist, finely laminated, buff siltstone. The site was again visited a year later, and a complete impression of Semionotus was obtained. The discovery was brought to the attention of Dr. David Dunkle, associate curator of the Division of Vertebrate Paleontology of the Smithsonian Institution, who secured permission from the state government of Virginia to excavate the outcrop. A number of ganoids previously unknown to this area were discovered, some exhibiting important variations from species found elsewhere in the Newark System.

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[1] The authors are indebted to David Dunkle and Frank L. Hess for their valuable assistance in preparing the manuscript for publication and to Edward Wagstaff for aid in field surveys.

[2] Formerly with U. S. National Bureau of Standards.

[3] Now with the U. S. National Bureau of Standards Field Service, Sterling, Virginia.

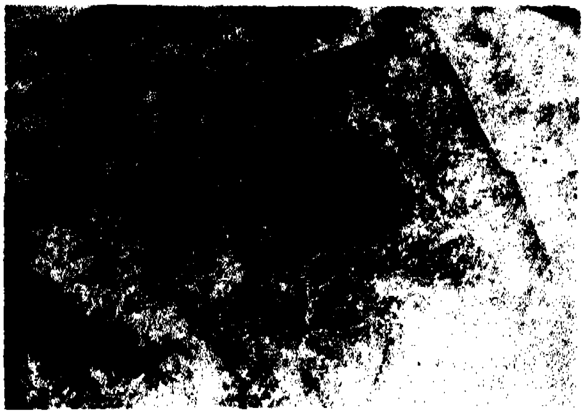

FIG. 1.

On March 6, 1949, further investigation in this district by Edward Wagstaff revealed a small exposure of a highly fossiliferous, dark-gray calcareous shale in the bed of Cotletts Branch, a small brook tributary to Broad Run. The exposure lies roughly one-fourth of a mile northeast of the roadcut. The shale is carbonaceous, very fissile, and considerably indurated. It yielded more distinct imprints and some well-preserved, more or less complete aggregates of scales, fins, and heads. Many of the components of the aggregates appear to be in their original form and proper relationships. The scales are highly polished and jet-black, presenting a marked contrast to the lighter-colored shale.

On July 4, 1946, in a search for agate (?), the float along Licking Run in Fauquier County was checked over a considerable distance. About one-quarter of a mile west of a narrow diabase dike a small fragment of dark, carbonaceous shaley limestone bearing jet-black, polished fish scales was found on a dry bar. On April 24, 1949, two years after the abnormally hard freezing and high waters of the winter of 1946–47, many more shale fragments containing fish remains, including one whole fish, were found on the same bar. Black rhombic scales and other parts of various fishes in an excellent state of preservation were fossilized in a dark, very fissile shale similar to that of the Cotletts Branch exposure, but much less indurated and more friable. Intermingled fragments of a coarsely laminated semicrystalline limestone also contained imprints. Some of the fossils were by far the best preserved of all fish found in the Potomac area up to this date. In the float, a large slab showed a nearly intact specimen of Redfieldius, about 9 in. long, with a beautiful mosaic of the scales and harder parts of the fins and head (Fig. 1).

Dr. Dunkle was informed of the discovery and accompanied Baer to Licking Run on May 7, 1949. The outcrop proved to be a veritable mine of fossil ganoids. The run was practically at the same stage of flood as on April 24, 1949, but warm enough by this time to permit comfortable wading. An extensive exposure of the fossiliferous shales, entirely submerged in midstream, was easily quarried by hand. Some of the softer layers appeared to be literally soaked with greasy bitumens, and in these the highest concentration of fossils was found, including most of the best preserved specimens.[4]

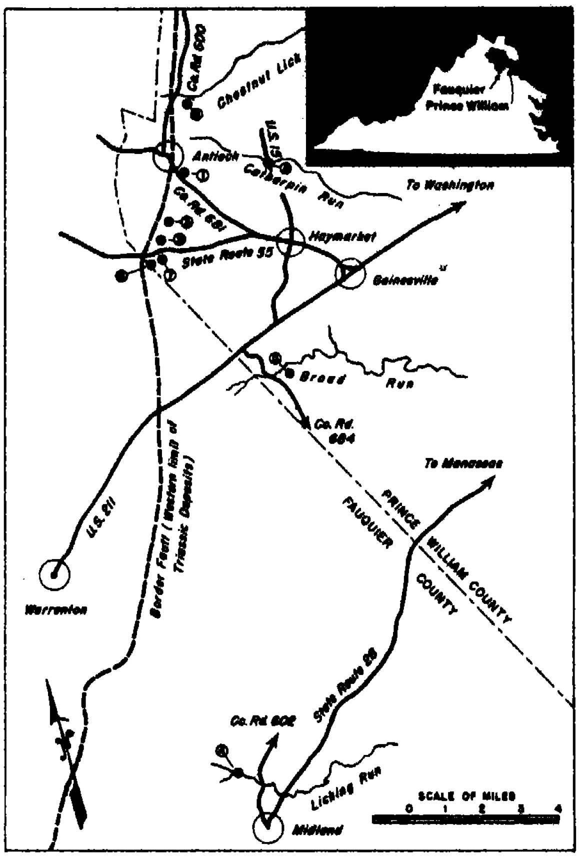

FIG. 2. Sketch map indicating approximate locations of the exposed fossiliferous shales. 1—Exposure in roadcut near Antioch. 2—Siltstone exposure in roadcut on State Route 55. 3—Cottletts Branch. 4—Licking Run location. 5—Broad Run location. 6—Millbrook Quarry. 7—Exposure in small stream near Millbrook Quarry. 8—Chestnut Lick exposure. 9—Exposure in excavation for bridge abutment, 5 ft below surface on U. S. Route 15.

NOTE: The U. S. National Museum has priority at the present time to remove material from the indicated fossil beds. Others must obtain permission to disturb the exposures.

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[4] Nodular lensiform masses, 3–5 in. long, were occasionally observed in the semicrystalline facies of the fossil beds. All specimens examined contained nuclei of nearly complete fossil fish.

About 30 pounds of fossiliferous slabs and fragments were selected and carried to the U. S. National Museum. Specimens of Catopteridae and Ptycholepis were particularly abundant. One large and very interesting impression was later classified as *Diplurus*. Small nodules, possibly coprolites of Triassic reptiles replaced by a phosphoric, carbonaceous material, were much in evidence (*2*).

The following approximate measurements of the exposures on Licking Run were taken under water, beginning with typical Manassas sandstone and extending into Bull Run shale:

8 ft—Pink and yellow shale with a few sandstones.
3 ft—Compact shale, alternating with thinly laminated siltstone.
1½ ft—Dark, carbonaceous, very fissile shale.
½ ft—Dark, carbonaceous, coarsely bedded semicrystalline limestone.
Fossil beds
3½ ft—Thinly laminated siltstone and compact shale.
10 ft—Buff shale and sandstone.
……… —Typical red shale and sandstone.

This sequence is repeated with some variation in thickness at an exposure on the south branch of the south fork of Broad Run. However, in other exposures along a roadway near Antioch, along Chestnut Lick, in the Millbrook Quarry, in a small stream near by, and in the excavation for a bridge abutment along U. S. Highway 15 at Catharpin Run (Fig. 2), the basal sedimentary strata are concealed and the carbonaceous fossil beds have greater thicknesses (5 ft or more), grading upward into the typical red shale and sandstone. In the Millbrook Quarry, where considerable core drilling has been done, the dark shales grade downward into a dark, arkosic conglomerate having a known thickness of 180 ft. The two easternmost exposures on Licking Run and on Broad Run indicate a thinning-out of the dark shales, and farther eastward the chances of encountering the fossil beds seem small.

Wherever scales occur *in situ*, it is probable that more or less complete preservations of fish exist near by. Therefore, it seems safe to assume that fossil fish may be found in a belt at least 18 miles long and approximately 2½ miles wide near the western Triassic border adjacent to the Bull Run Mountains, where scales are found in numerous exposures at well-spaced intervals. The discoveries outlined in this paper, not to mention the additional collecting possibilities in the entire fossiliferous belt, are significant if only because no ganoid fossils other than isolated scales have, to the knowledge of the authors, been recorded heretofore from the Triassic basins of northern Virginia. Furthermore, the character of the occurrence in siltstone near Thoroughfare Gap appears to be unique in the history of the Newark System.

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Colchicine Poisoning in Relation to Hemerocallis and Some Other Plants

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Colchicum species contain appreciable amounts of colchicine (*4, 5*). According to Blakeslee (*1*) and Levan (*3*), *Colchicum* species they tested were not subject to colchicine poisoning under the conditions of their experiments.

On the basis of these reports, it would seem logical to assume that plants, other than *Colchicum* species, which also contain appreciable amounts of colchicine, might likewise be immune to colchicine poisoning. However, this hypothesis apparently has not as yet been tested. According to Klein and Pollauf (*2*), the presence of colchicine in *Hemerocallis fulva* L. has been demonstrated microchemically; but extensive experiments by the present writer have shown that *Hemerocallis* species, including *H. fulva* L., and various hybrid clones tested, are very sensitive to colchicine, and concentrations in aqueous solution in the range from 0.025% to 0.1%, tested with appropriate application techniques, proved to be quite effective in inducing polyploidy. Concentrations much above 0.1% usually led to the eventual death of the treated plants.

A number of colchicine-induced *Hemerocallis* polyploids have flowered. Their polyploid nature was established on the basis of chromosome counts, and pollen grain and stomate size. One polyploid, Tetra Starzynski, $n = 22$, a tetraploid of the clone Mayor Starzynski, $n = 11$, has been named. Its flowers are larger and finer-colored than those of the diploid form. This removes all doubt about the effectiveness of this compound as a mutagen in this genus. The object of the present note is not to elaborate here on these results, which will be reported in detail elsewhere, but rather to consider very briefly their implication, particularly with reference to the validity of the microchemical method used for determining colchicine.

Klein & Pollauf (*2*) used a microchemical procedure for the determination of colchicine in *Hemerocallis fulva* L. In view of the marked sensitivity to this compound of *Hemerocallis* species, including *H. fulva* L. and hybrid clones, their results require verification. If their report can be verified, then it would appear, in this instance at least, that plants which contain relatively smaller amounts of colchicine could be affected by the application of relatively larger amounts of the compound. It is also desirable to check the reported colchicine content of species in other genera. In this connection, it is of interest to note that *Gloriosa rothschildiana* O'Brien (a plant closely related to *G. superba* L., which is reported to contain colchicine) is subject to colchicine poisoning in the range tested, 0.05%–0.2% concentrations, particularly in the case of small seedling tubers.

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Preparation of a Radioactive Oxazine Dye[1]

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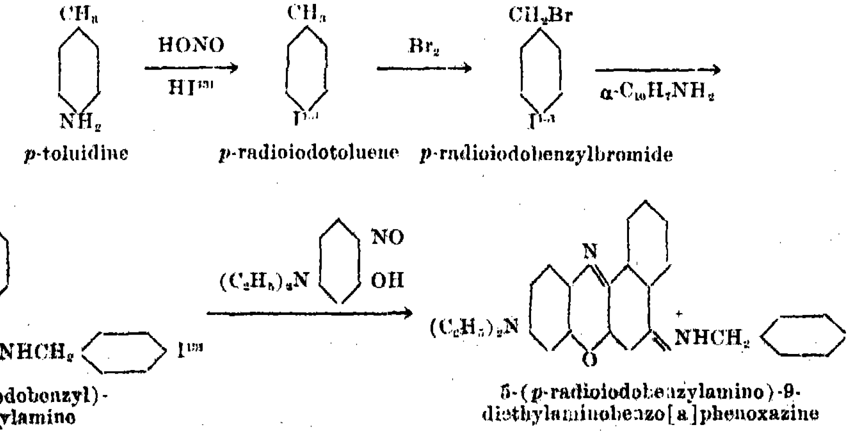
The discovery (*2*) that the oxazine dye Nile blue A stains and retards the growth of malignant tumors in mice stimulated the investigation of related compounds. Of the oxazine dyes tested on mouse tumors (*1*), the one known as Nile blue 2B, Colour Index No. 914 (*5*), showed the greatest affinity for tumor tissue. The halogen derivatives of Nile blue 2B have been prepared (*3*) with the intent of using one of them as a "carrier" of radioactivity to the tumor tissue when radioactive halogen is present in the molecule. It is the purpose of the present paper to describe the preparation of the radioactive iodine derivative of Nile blue 2B.

The synthesis of this radioiodo dye was carried out (without isolation of intermediate compounds) by the following series of reactions:



p-toluidine

p-radioiodotoluene

p-radioiodobenzylbromide

N-(*p*-radioiodobenzyl)-α-naphthylamino

5-(*p*-radioiodobenzylamino)-9-diethylaminobenzo[a]phenoxazine

A solution of 3.3 g of *p*-toluidine in 35 ml of water and 3.6 ml of concentrated sulfuric acid was carefully diazotized at 5° C with 2.1 g of sodium nitrite in 20 ml of water. To 18.5 mc of carrier-free I^{131} [2] in 15 ml of water, was added 5 g of potassium iodide and this solution was slowly added to the cold diazotized solution. A small quantity of sodium sulfite was added to reduce any iodine. The mixture was kept in an ice bath for 30 min, then at room temperature for 1 hr, and then heated gently on a steam bath for 1 hr. The resulting mixture was then steam-distilled until 250 ml of distillate was obtained. The distillate was made decidedly alkaline with sodium hydroxide solution, a small amount of sodium sulfite was added to it, and then it was extracted with 150 ml of carbon tetrachloride.

This solution of *p*-radioiodotoluene in carbon tetrachloride was washed three times with water and then evaporated to a volume of about 50 ml. To this solution was added 1.55 ml of bromine in 25 ml of carbon tetrachloride, and the reaction flask was attached to an efficient all-glass reflux condenser. The flask was illuminated by two 200-w clear Mazda lamps, and heated at gentle reflux for 3 hr, at which time the evolution of hydrogen bromide had ceased. The mixture was then cooled to room temperature and 5 g of potassium iodide in 25 ml of water was added. Sodium thiosulfate solution (approx. $N/10$) was then added till all iodine was reduced. The carbon tetrachloride layer was separated and washed with water. The carbon tetrachloride was distilled off on a steam bath.

The resulting *p*-radioiodobenzyl bromide was dissolved in 50 ml of ethanol and to this was added a solution of 12 g of α-naphthylamine in 50 ml of ethanol. The mixture was heated in a water bath under reflux condenser for 2 hr. The ethanol was distilled off and the residue extracted three times with 100-ml portions of 1 : 50 hydrochloric acid to remove excess α-naphthylamine.

The resulting N-(*p*-radioiodobenzyl)-α-naphthylamine (containing a small quantity of α-naphthylamine) was dissolved in 75 ml of ethanol and 9 ml of concentrated hydrochloric acid. To this was added a solution of 10 g of 2-nitroso-5-diethylaminophenol in 25 ml of ethanol. The mixture was gently boiled under reflux condenser for 3 hr and then allowed to stand overnight. After cooling in an ice bath for 1 hr, the product was filtered and washed with cold ethanol and then with ether. The weight of product obtained was 8 g.

Radioactivity of the dye was measured, using a thick-window, cylindrical, gamma-ray Geiger-Müller tube. An

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[1] Aided in part by a grant to Dr. Margaret R. Lewis from the National Cancer Institute.

[2] Obtained from Oak Ridge National Laboratory.

accurately weighed sample of the dye was dissolved in ethanol (about 0.1 g per 100 ml) and a 0.50-ml aliquot was placed on a 1-in. square of filter paper. As soon as the ethanol had evaporated, the paper square was placed between gummed paper labels. This was placed in direct contact with the Geiger-Müller tube with a tight rubber band. The Geiger-Müller tube was calibrated by counting in identical fashion an aliquot of the original I^{131} solution which had been assayed at the Oak Ridge National Laboratory. The activity of the dye, measured in this manner, was 0.55 mc/g.[3]

This radioactive dye has been administered to tumor-bearing experimental animals and to a small number of human subjects. Results appear elsewhere (*4*).

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Occurrence and Life Histories of Commercial Shrimp

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Grooved shrimp (*Penaeus*, Division II) are unusually prominent in the North Carolina catch. Study of the species has been impeded not only by lack of means to distinguish them from each other before adolescence (or to distinguish their eggs and larvae from those of the ungrooved *P. setiferus*, with which it seems possible that Pearson (*3*) has confused them), but by lack of means for rapid field identification of adults. A simple diagnostic test for the commercial sizes of the two grooved species common in continental North America is that *Penaeus duorarum* Burkenroad, the spotted shrimp, bears a reddish brown midlateral patch at the juncture of third with fourth pleonic segment. This pigmented spot, first called to my attention by Captain O. Purifoy, is larger and denser than the one at the midlateral hinges that lock the other pleonic somites together, or the one at the equivalent site in *P. aztecus* Ives, the brown shrimp. Field confirmation of the rapid diagnosis is seen in the difference between the common North American forms of these two species in width of groove alongside the middorsal carina of sixth pleonic segment (*1*).

No special fishery for spotted shrimp has previously been described. A 10-year-old one in the shallow Straits between Core Sound and Beaufort Inlet, North Carolina, employs some seventy channel nets, like boardless, long-winged otter trawls, which are staked or anchored in strong tide-currents during night ebb in May, June, and July. These stationary tide traps intercept shrimp swimming off the bottom (presumably migrating to sea). A catch of over a ton by one 75-ft net on one ebb has been reported, but the annual production of the whole fishery is probably around 100 tons. The catch, especially prized for hardness, sometimes contains a proportion of brown shrimp but is chiefly immature *P. duorarum*. Since grooved shrimp in the North Carolina commercial trawl catch are mostly *P. aztecus*, the tide traps evidently select the spotted species from an inshore and inside grooved shrimp population which is as a whole preponderantly of brown shrimp. There is evidence, however, that young spotted shrimp are in the majority on the shallowest bottoms of the saltier sounds.

During the last decade, the proportion of grooved shrimp in the annual North Carolina catch has probably fluctuated between a third and a half. Brown shrimp have always been prominent in the catch of Carteret County, but testimony from fishermen suggests that since 1936 these shrimp have become absolutely, as well as relatively, more abundant not only there but on the grounds farther south around Cape Fear, which before 1936 supplied a larger share of the state's catch, including a higher proportion of the gray shrimp, *P. setiferus*. Since there are indications of unusual abundance of *P. aztecus* during the same period along its whole Atlantic Coast range, it seems possible that the population of this species has undergone a recent increase. Such an increase may have contributed to the development since 1936 of an extensive new fishery in Pamlico Sound. This, the most northern American market fishery for peneid shrimp, sometimes supplies more than a third of North Carolina's production, chiefly from a summer run of relatively large brown shrimp.

Brown shrimp in North Carolina shoal-water catches are often nearer maturity than is usual along the more brackish shores of Louisiana, but the spawning grounds of the North Carolina population have not yet been found. Sporadic offshore catches of jumbo shrimp by winter fish trawlers in the Hatteras-Lookout area are chiefly of gray and of spotted shrimp; and a reliable and widely experienced North Carolina fleet owner, Mr. L. Hardee, who has encountered the abundant, though scattered, orange-colored, yellow-roed breeding population of *P. aztecus* present off Louisiana in 15–70 fathoms the year round (*1*), does not know of a North Carolina equivalent.

Although this apparent scarcity of adult brown shrimp off North Carolina may simply reflect the inadequacy of exploration, it is not necessarily inconsistent with the high density of the state's inshore immature population. Half-grown brown shrimp appearing in New Jersey in midsummer are evidently postlarval immigrants (*1*). It is therefore conceivable that North Carolina brown shrimp, in contrast to the endemic spotted kind, chiefly originate farther south.

It should be observed that, as long as the Atlantic habitat of mature brown shrimp remains unknown, the belief that there is no extensive Atlantic deepwater population of gray shrimp (*4*) cannot be regarded as unquestionable. There is also some basis for questioning the related belief (*2*) that *P. setiferus* normally dies after only one or two spawnings, and without surviving a second winter; since the gray shrimp, like the brown, continues to molt after beginning to spawn; and since a large proportion of adult females, including many nearly ready to spawn again, already show traces of previous spawning in early spring.

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[1] Private laboratory: Ecos, Bogue Sound Road, Newport, North Carolina.

[3] Miss Ruth E. Brown assisted with the radioactivity measurements.

King's suggestion (*2*) that nature has failed to make "proper provision for the egress" of the eggs of *P. setiferus*, evidently results from failure to detect ripe eggs left behind in the spawned ovary except when retention was abnormally great. Normally, there is only a sparse scattering of leftover ripe eggs (*1*). For example, among a sample of 67 unripe and ripening hard-shelled North Carolina May adults, most or all of which had spawned previously, such eggs could be detected in 26 by teasing 0.1 ml ovarian samples. The average number of leftover eggs per positive sample was less than two, and the maximum ten.

Remains of spermatophores attached to female gray shrimp offer a second clue to previous spawning. These remains are of two distinguishable types: glutinous remnants grading up to large fragments, and found only in some of the very ripe, which are evidently from recent spermatophores accidentally torn away before spawning; hard traces, never conspicuous, and least frequently detectable in ripe individuals, which are evidently left after normal spermatophore dissolution at spawning. In a sample of 99 unripe and ripening hard-shelled females from the same catch as and including the 67 examined for leftover eggs, 82 bore recognizable spermatophore traces. Since those lacking spermatophore traces bore leftover eggs in about the same percentage as did the whole sample, and vice versa, it appears that even among those not displaying either indicator, most or all had spawned before.

Among very ripe females of the same catch, minute spermatophore traces were detectable in 15 of 31 closely examined. The catch (trawled near shore at Cape Fear in late May, 1949, by Mr. Carter Broad of the Institute of Fisheries Research) included a total of some 130 very ripe, 160 ripening, and 120 unripe adult females. None of this particular catch seemed newly mated or newly spawned. Seven, all unripe, were soft-shelled; of which three had leftover eggs.

It will be seen that the previously misinterpreted distribution of spermatophore traces among female gray shrimp from deepwater catches off Louisiana in March (*1*) suggests the presence of survivors of the preceding season's spawning.

Xiphopeneus kroyeri (Heller), sometimes abundant in Louisiana and a prominent commercial shrimp of Brazil, has not been previously reported from North Carolina. Three ripe females of this species occurred with the catch from Cape Fear, just mentioned.

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Periodate Oxidation in the Study of the Structure of Dextrans

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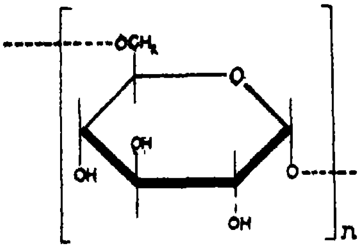
It was predicted by Brown *et al.* (*1*) that pyranoid 1–6 polyglucosans (dextrans) should behave in a distinctive manner toward periodate ion by means of which dextrans may be distinguished from other polysaccharides. Oxidation with potassium *m*-periodate cannot be utilized for the determination of the mean chain length since each 1:6-glucopyranose residue undergoes oxidation with the liberation of 1 mole of formic acid by virtue of the fact that each such residue possesses hydroxyl groups on three contiguous carbon atoms. Thus, a "straight chain" 1:6-polyglucose, provided that all the units are pyranose, will behave in a manner analogous to a methyl glucopyranoside as far as the production of formic acid is concerned. It follows that the equivalent weight of such a dextran, i.e., the weight of material yielding 1 mole of acid, will be numerically equal to the equivalent weight of a single glucose residue, viz., 162.



However, any 1–6 glucose residue which is triply linked and thus constitutes a point of branching in the molecule, will not yield formic acid no matter whether the side chain be attached at C_2, C_3, or C_4. (This will also be true for any furanose units or residues linked other than 1:6-). The presence of numbers of such points of branching will be manifest in an experimental value for the equivalent of a dextran greater than the calculated value. From the difference in these two values it should be possible to determine the ratio of branched residues to straight residues.

A detailed study of the periodate oxidation technique has been carried out by Pacsu *et al.* (*5*) in which the limits of accuracy for the determination of formic acid in the presence of comparatively large amounts of reducing substances have been defined, the best results being obtained by titrating potentiometrically to a given pH. In the case of the dextrans, the total amount of formic acid liberated is considerable (cf. oxidation of starch) and it is not until the end point is reached that interference from other products of oxidation becomes significant; notwithstanding this, the total amount of acid can be determined with considerable accuracy.

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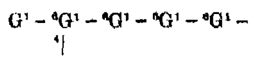
[1] Rockefeller Foundation Fellow at Princeton University.

A series of studies were made upon the rate of oxidation, simultaneously and under identical conditions, of α-methyl glucoside, β-methyl gentiobioside, *Leuconostoc mesenteroides* dextran (*7*) and *Leuconostoc dextranicum* dextran (*6*). In all cases the rate of reaction was almost identical and the equivalent for the first two substances agreed closely with the calculated value. *L. mesenteroides* dextran was found to have an equivalent of 204, i.e., 1.25 × theory. Thus from 5 glucose units only four yield formic acid or, in other words, 1 unit in five is engaged in side branching. This evidence indicates a structure:

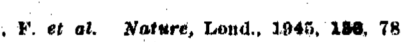


$$G^1 - {}^6\underset{{}^4|}{G}{}^1 - {}^6G^1 - {}^6G^1 - {}^6G^1 - \qquad (I)$$

[G represents a glucopyranose unit and the superscripts, the points of attachment] proposed by Fowler *et al.* (*4*) on the basis of methylation studies, by which it was shown that the molecule consists entirely of glucopyranose units. The following partly methylated sugars were isolated: 2 : 3 dimethyl methyl glucoside, (one part 22.6%), 2 : 3 : 4 : trimethyl methyl glucoside (three parts 57.9%) and 2 : 3 : 4 : 6 : tetramethyl methyl glucoside (one part 19.6%).

On the constitution of the dextran from *L. dextranicum,* there has been some divergence of opinion (*2, 3, 6*) concerning the significance of the amounts of tetramethyl and dimethyl methyl glucosides obtained from the hydrolyzed methylated polysaccharide. Evans and Hibbert (*2*) suggested that the quantity of dimethyl sugar was excessive, due to incomplete methylation of the material. Fairhead, Hunter, and Hibbert (*3*) identified in their hydrolyzate, 2 : 3 : 4 : trimethyl methyl glucoside (four parts, 90%), and a dimethyl methyl glucoside (one part, about 10%). Peat, Schlücterer and Stacey (*6*) detected 0.23% of 2 : 3 : 4 : 6 : tetramethyl methyl glucoside in their material in addition to 2 : 3 : 4 : trimethyl methyl glucoside (four parts, 90%) and 2 : 3 : dimethyl methyl glucoside (one part, about 10%).

By periodate oxidation, the equivalent of this dextran was 187, i.e., 1.15 × the theoretical value. This would indicate that at least one glucose residue in eight is engaged in branched chain formation, and this is in accord with the structure II proposed from the methylation data.



$$G^6 - {}^1\underset{{}^4|}{G}{}^6 - {}^1G^6 - {}^1G^6 - {}^1G^6 - {}^1G^6 - {}^1G^6 - {}^1G \qquad (II)$$

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The Potentiating Effect of Glucose and Its Metabolic Products on Barbiturate Anesthesia

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In July 1944, we studied shock from hemorrhage, using a large number of dogs, most of them anesthetized with pentobarbital sodium (nembutal) given intravenously early in the morning. The dogs were then bled and various procedures carried out on them during the day. Most of these dogs recovered slowly from the anesthetic in the evening. On one occasion, when we were about to inject glucose (10 ml of a solution of 50 g glucose dissolved in 100 ml of water) intravenously, the dog suddenly came out of anesthesia. The animal responded normally when spoken to and tried violently to get off the table. It was with difficulty that the intravenous injection of glucose was made. Instantly the dog relaxed, going into deep sleep and complete anesthesia exactly as after an injection of a barbiturate. The result was so striking that when the dog again recovered suddenly, an hour later, a fresh glucose solution was injected. This produced the same effect, that is, immediate sleep and anesthesia which, however, lasted only 45 min. The dog then went through this cycle of sudden awakening and then immediate sleep and anesthesia after an injection of glucose. The duration of sleep after each glucose injection was 1 hr, 45 min, 30 min, 20 min, 10 min, and 5 min, respectively. Then further injection of glucose produced no sleep, the dog remaining awake and, if anything, hyperexcitable.

In several dogs similar results were seen, but others treated in the same way recovered slowly from the anesthetic and did not go to sleep again after glucose was injected.

This observation was reported to the Office of Scientific Research and Development Committee on Shock, but the work they had been supporting was discontinued and considerable time passed before it was taken up again.

At first we associated this phenomenon with shock, or the extremely high temperatures which occurred in our dogs at this time, when the temperature of our laboratory was well over 100° F. Later, in studying approximately 100 dogs, shock and artificially produced high temperature were eliminated as factors producing the reaction, and it was found that a small percentage of normal dogs given pentobarbital sodium or hexobarbital soluble (evipal) reacted to the subsequent intravenous injection of glucose on awakening, as our shocked dogs did. An occasional dog reacted as strikingly as our first dog. Others reacted little or not at all to the injection of glucose. Because we were unable to reproduce this reaction at will, its study was greatly hindered.

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[1] Funds for carrying on this work were kindly supplied by the Mallinckrodt Chemical Works.

Finally, in 1948, guinea pigs were tried, using hexobarbital intraperitoneally as the anesthetic. On awakening, the animals were given glucose, also intraperitoneally. Practically 100% of the guinea pigs responded with a return to sleep after awakening from hexobarbital, when 1 ml of glucose solution was injected intraperitoneally. Rats do not behave in the same way; rabbits and hamsters do, but with more delay in the onset of anesthesia after glucose.

As yet we have not developed an accurate quantitative method for studying this reaction. Guinea pigs were given a dose of hexobarbital intraperitoneally, 0.20–0.25 ml of a 2% solution per 100 g of pig. They went to sleep in about 2 min and slept for about 45 min but varied considerably in time of awakening. When the pig was definitely awake and responded to stimulation, but before it could run around, glucose, or whatever substance was being studied, was given intraperitoneally. The pig usually responded instantly or within 5 min, and went to sleep on its side. It would at first respond slightly to a pinch of the foot by squealing, but more violently if the back of the neck was pinched. After 5 min, there might be no reaction of any sort after pinching the foot or neck. In about 45 min, the pig woke up and often could be put to sleep by a second dose of glucose. If too long a time passed before the second injection was made, there was no response.

At present our best criterion of effect from the injection of a given substance is the return to sleep and anesthesia after awakening from the hypnotic. The duration of sleep is too variable for quantitative work unless large numbers of animals are used. After hexobarbital over 30 pigs have responded to the intraperitoneal injection of 1 ml of 50% glucose and only a rare pig has failed to respond, although the degree of response varies. They have responded well to the injection of 5% glucose in doses of as much as 10 ml in a 500-g pig and as little as 1.25 ml or approximately 12 mg/100 g of pig. The injection of glucose alone causes no sleep or anesthesia.

That this is not an osmotic effect is shown by the fact that solutions of sucrose, as well as of sodium chloride of the same tonicity, do not produce such an effect. We have obtained this reaction to glucose after hexobarbital, narconumal, seconal sodium, and pentothal sodium; but have obtained no such reaction to glucose after ether, chloral, or chloralose. We have found that intermediary products of glucose metabolism such as hexose diphosphate, lactate, pyruvate, succinate, and fumarate, as well as malonate, and the water extract of both brewer's and baker's yeast produce the same effect, some more strongly than glucose. Sucrose, as already stated, produces no such effect; arabinose only a slight effect; and galactose and levulose a definite effect, but less than glucose.

To observe this reaction, inject a guinea pig intraperitoneally with a 2% solution of hexobarbital soluble (0.25 ml/100 g of pig). This will cause sleep for about 45 min to an hour. When the pig wakes up and responds well to pinching, but before it can run, inject 2 ml of 50% sodium lactate (Mallinckrodt). (0.1 ml is effective). This has consistently produced such a pronounced depression that there is no doubt about the result. The same reaction is produced regularly in dogs by lactate, malonate, or succinate.

As far as we are aware, the observations given here have not been reported before, although the literature on the relationship between glucose and its metabolic products to anesthesia is enormous and sometimes conflicting. Our results in dogs show very wide variation in response to glucose after barbiturate anesthesia; the great difference of reaction in animal species might account for this. Our results are qualitative only, excessively large doses having been given at times to insure a reaction of an active substance. The effect of each compound used has, however, been controlled by injection of a corresponding amount of the substance in a normal animal without anesthetic; such injection has in no case produced depression.

After this article had been written, it was found that, although the duration of hexobarbital anesthesia did not seem to be greatly changed by the simultaneous administration of glucose or its degradation products, in the few experiments tried, these substances greatly affected the dose of hexobarbital necessary to produce anesthesia, lowering it roughly from 0.15 ml of 2% hexobarbital solution to 0.01 ml when 2 ml of 50% sodium lactate was given at the same time. The potentiating effect of glucose was striking, but less than that of lactate. Pigs which showed no response to a subanesthetic dose of hexobabital went to sleep at once after the injection of glucose or lactate.

It would therefore appear that we have been dealing with a potentiation of barbiturate anesthesia by glucose and its metabolic degradation products and that the return to a state of hypnosis or anesthesia after waking from barbiturate sleep is probably due to a potentiating effect of these substances on the subanesthetic level of barbiturate in the blood.

Detailed reports of our work will be published later.

Comments and Communications

On the Discovery of the Action of Colchicine on Mitosis in 1889

The description of the effects of colchicine on mitosis by A. P. Dustin (*Bull. Acad. roy. Med. Belg.*, 1934, 14, 487) and F. Lits (*C. R. Soc. Biol.*, 1934, 115, 1421) marked the beginning of a period of active investigation. During the next 15 years, publications dealing with this alkaloid averaged about 100 titles per year. The first study of the action of colchicine on mitosis, we now believe, is the one published by B. Pernice (*Sicilia Med.*, 1889, 1, 265). Several papers since 1934 have credited W. E. Dixon and W. J. Malden (*A manual of pharmacology*. London: Arnold, 1906, and *Physiol.*, 1908, 37, 50) with the original observations on colchicine mitosis. They mentioned that after repeated injection in mammals, ''plentiful mitotic figures can occasionally be observed'' in smears of bone marrow. However, they did not give details or illustrations. On the other hand, the figures and text of Pernice make it clear that he observed in considerable detail the cytological action of this drug.

We have been interested in colchicine bibliography (*Lloydia*, 1947, 10, 65) for the past ten years, and a work now in press (*Lloydia*) includes a reference to this work of Pernice. Through the service afforded by the U. S. Army Surgeon General's Index, and the cooperation of the Library of the U. S. War Department, Washington, D. C., we have been able to study this document. Greater details, as well as presentation of figures, will be published when suitable arrangements can be completed. However, at the moment, certain sentences are so appropriate that a few of Pernice's observations are included, with our comments.

In his paper, entitled: ''On the karyokineses of the epithelial and endothelial cells in the mucosa of stomach and intestine, in experimental gastroenteritis following colchicum poisoning,'' Pernice studied with great care the gastrointestinal mitoses in two dogs given, respectively, 10 and 15 g tincture of bulbs of colchicum, and dying 24 and 48 hr later. In the stomach were to be found ''*an extraordinary great number of dividing cells.*'' Furthermore, he stated that within the Lieberkühn glands of the intestine, ''nearly all cells are engaged in indirect division.'' Endothelial mitoses can be seen ''nearly in all vessels.'' Moreover, it is ''*rare to see the latest stages of division.*'' Pernice considered that ''the cellular elements may have been directly excited and stimulated by the tincture of colchicum.'' He noticed that some of the mitotic figures apparently *underwent destruction* and added: ''Perhaps this is a necrosis of the cells, giving rise to some sort of pseudo-karyokinetic forms.'' He firmly stated, however, the relation of the observed images to true mitosis. The illustrations show gastric and Lieberkühn glands, one with ''*quasi tutti gli elementi in cariocinesi,*'' and divided equatorial plates, but no true anaphases or telophases are represented.

Pernice deserves due credit for his discovery; thus the action of colchicine on mitosis has been known since 1889. While many physiological studies of the intestine in colchicinized animals were published in the interval from 1889 to 1934, the mitotic abnormalities were not described again until 45 years later. The year 1949 marks the 60th anniversary of the discovery of colchicine mitosis.

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A Nomination for the ISCC

My hearty approval of the article on Ridgway's color standards (*Science*, June 17).

You will find that I have been active in the past in an attempt to produce color standards which will be both permanent and reproducible. Inorganic ions and compounds were found to be permanent and could be accurately reproduced from known formulas; ferric chloride and cobalt chloride were the compounds employed. The nickel ion would probably have been the next, had I been able to continue the study.

The American Society for Testing Materials, neighbors of mine on Race Street, Philadelphia, have already done excellent studies on the color problem and know much of its intricacy. They might be the best available organization for the purpose mentioned in Dr. Middleton's letter (*Science*, June 17).

John Pim Carter

Academy of Natural Sciences, Philadelphia

Solar Rotation and Kepler's Laws

H. W. Babcock, of Pasadena, recently announced discovery of some significant correlations between the magnetic fields and the rotation of several astronomical bodies. P. M. S. Blackett, distinguished English physicist, found that Babcock's constant $Q/mr^2\omega$, or magnetic moment/angular momentum, is proportional to $G^{1/2}/c$, or square root of gravitation constant/velocity of light.

In calculating angular velocity, Prof. Blackett took the sun's equatorial time of rotation, about 25 days. But the sun does not rotate uniformly like a solid sphere and different values are found when the average time of rotation is used (i.e., mean of observed latitudes). This is a little more than 29 days, or about 2,510,000 seconds.

Substituting for m the equivalent term v^2r/G, angular momentum would be given by $v^2r^3\omega/G = 2.4 \times 10^{49}$ in c.g.s. units and $\frac{Q}{v^2r^3\omega/G}$ would be $8.9 \times 10^{33}/2.4 \times 10^{49} = 1/2.6 \times 10^{15}$. This would be proportional to $1/G(2\pi c)^2$ (i.e., approximately $1/2.4 \times 10^{14}$).

One of the factors abstracted from the equations, $r^3\omega$, or cube of sun's radius multiplied by its angular velocity, is proportional to a Keplerian constant for the solar system, $2\pi rv^2$, or planetary orbit multiplied by the square of orbital velocity, e.g., in cm/s units:

$$2\pi rv^2 = (6.28 \times 6.95 \times 10^{10}) \cdot (4.38 \times 10^7)^2 = 8.37 \times 10^{26}$$
$$r^3\omega = (6.95 \times 10^{10})^3 \cdot (6.28/2{,}510{,}000) = 8.4 \times 10^{26}$$

This equivalence suggests that planetary motions are related to the sun's rotation and regulated by electromagnetic laws, as Kepler surmised.

CORNELIUS O'CONNOR

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Corneal Contact Lens Reference?

It has been widely quoted that Sir John Herschell was the first to suggest the possibility of making a corneal contact lens. Can any of your readers give us the exact reference in Sir John's writings regarding this idea?

KATHERINE FERGUSON CHALKLEY

Manuscript Editor
American Journal of Ophthalmology,
Lake Geneva, Wisconsin

Guarded Circuit Bridge

A precision guard circuit has been constructed to operate in conjunction with a Modified Schering Bridge so that three terminal guarded measurements can be made on solid and liquid dielectrics over the operating frequency range of the bridge; namely, 100 cycles/sec to 300,000 cycles/sec.

The detector system used with this equipment is made up of a matching amplifier with built-in selective frequency filters between the output of the bridge and main amplifier. The main amplifier has a flat frequency response of 40 db from 60 cycles/sec to 1,000,000 cycles/sec. The output of the main amplifier is fed to one set of plates of a standard oscilloscope. The other 'scope plates are fed directly from the bridge supply oscillator through a phase shifter.

Amplifiers are operated at full gain with the signal forming an ellipse on the 'scope screen. Controls are adjusted so that resistance balance opens and closes the ellipse and capacity balance tips the closed line right or left from horizontal.

Accurate balance is obtained over the complete frequency range of the bridge.

The guarded circuit bridge enables one to make dielectric constant and dielectric loss measurements under controlled humidity conditions and at different temperatures, which are impossible with a two-electrode system. Surface leakage on a dielectric cannot be separated from volume resistance using an unguarded bridge. Edge corrections for electrostatic fringing are also eliminated by means of the guarded test electrode.

STANLEY I. REYNOLDS

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Report from Sweden

The more important scientific activities of the Scandinavian countries are known in this country by way of the Scandinavian journals and abstracts in our own American medical journals. Therefore, when I went to Stockholm to visit the larger hospitals and state and municipal laboratories, I did so with a good many preconceived ideas and the feeling of at least a surface familiarity with the work in progress. I found, however, a laboratory organization quite different from that in the U. S., owing to some extent, to the absence of large commercial pharmaceutical plants and also to the semisocialization of medicine in this country.

In this account I shall not attempt to give a complete picture of all the important laboratory activities in progress. My visits were confined almost exclusively to Stockholm. However, I was assured that the organization here is prevalent throughout Sweden.

Swedish laboratory medicine is now centralized to a large extent. In recent years demands for decentralization have increased, and to some degree plans for this process have been made and will be carried out within the next decade or two. Stockholm (and all the larger communities in Sweden) maintains one central municipal bacteriological laboratory that works with and for all the city hospitals except the Medical Institute—Karolinska Hospital—which is to a large degree self-sufficient. Individual hospitals maintain small bacteriological laboratories to do a few routine tests, but send most clinical diagnostic work to the municipal laboratories. But all the hospitals maintain adequate chemical, hematological and pathological laboratories.

The Municipal Bacteriological Institute is rather inadequately housed in an old converted school house, but plans for new quarters have been drawn up by the directing head, Prof. Davide. Funds are available and it is hoped that in three or four years the new quarters will be ready for use. The plans call for a continuation of the present organization into four scientific departments: clinical bacteriology, i.e., cultures and antibiotic tests; serology, including Wassermann and Widal tests, antistreptolysin titers, and staphylococcal lysin titers; intestinal infection; and tuberculosis. To this will be added a fifth and very important section—a virus department in which Prof. Davide tentatively plans an emphasis on encephalitis investigations.

Opportunities for research in the present cramped quarters are of necessity restricted. In the new building, however, adequate space for research is planned for, so that each department head will have a small laboratory for private scientific investigations. Prof. Davide is continuing his extensive 15-year work on bacterial metabolic products with bactericidal action on *Mycobacterium tuberculosis*. His associate, Dr. Pakalin, is also continuing with his work on the effect of generalized infections on the clinical course of tuberculosis. Both men were most kind in showing me their work, as were their staff, and the staffs in all the institutions I visited. English is generally spoken, usually very fluently, and older doctors speak excellent German.

No teaching is done at the municipal institute, but in the new quarters provisions are made for teaching clinical bacteriology to medical students. The staff consists of six doctors and about 20 technicians. The professional staff here and at the hospitals is predominantly male. I was assured constantly that the dearth of woman physicians merely reflected the fact that here women prefer a home and husband to a medical career. The technicians, on the other hand, are exclusively female. Incidentally, the status of the Swedish laboratory technician is considerably different from that of her American counterpart. She is not college-trained, but is given special training for a period of eight months to a year, to qualify her for routine laboratory work. All diagnostic results are supervised, checked, and officially reported by a member of the staff holding a university degree. This state of affairs is becoming more and more deplored by the laboratory directors, and there has been considerable agitation for more adequate scientific training of technicians.

I visited several of the hospitals of Stockholm. Two of these, Sabbatsberg (where the new municipal center will be housed) and St. Eriks, are good examples of the average city hospital. Both of these maintain only very small bacteriological laboratories, using the municipal center for almost all of their bacteriology, but maintain all the clinical laboratory divisions in adequate form. At Sabbatsberg, where the hospital is quite old but the laboratory quarters are housed in a new and extremely modern building, the main research problems are pathological, initiated by the director, Prof. Bergstrand, and concern morphological and biochemical analysis on changes in liver and kidney diseases. The equipment here, as indeed in all the laboratories except the municipal one, which will be completely reequipped, is astonishingly modern and considerably more than adequate. Binocular microscopes, usually of German, Swiss, or English make, are used exclusively. Large built-in, stainless steel autoclaves are found everywhere; stainless-steel centrifuges holding 24 tubes are of Swedish make and, I am told, excellent. There is usually no difficulty in obtaining the standard laboratory equipment. Libraries are, by American standards, inadequate. Each institute usually has only a small library of journals and books pertaining to its own medical specialty. However, the Karolinska Medical Library is excellent, fully equipped not only with American and central European works but also with a good selection from eastern Europe. This library is available to all the other medical institutions of Stockholm.

At St. Eriks Hospital, where Dr. Josephson was most kind in showing me his equipment, I was again impressed by the excellent laboratories in a comparatively old hospital. Here, as in all the other hospitals, there is a workroom with trained mechanics who can manufacture a good deal of the equipment. Dr. Josephson is working on the excretion and tubular function of kidney metabolism and plans to publish his results in a new English-language journal, the *Scandinavian Journal of Clinical and Laboratory Investigations*. I asked him about the effects of the semisocialization of Swedish medicine on research, and he assured me that, although he gets his funds from the Swedish State Medical Council, there is no state control of research at all, either in his own or in any of the other institutions.

One of the oldest hospitals in the city is the institution for epidemic diseases, aptly called Epidemi Hospital. Here again there are plans ready for a whole group of new buildings, especially a large central laboratory department, with adequate bacteriological and virus quarters. Dr. Hedlund, who is one of the consulting physicians there and in charge of the bacteriology laboratories, emphasized the fact that he and the other staff physicians will have adequate quarters in the new building for private research. He is engaged in serological studies on polyarthritis and hopes to continue along these lines. Like all the physicians I spoke to, he expressed the greatest interest in the U.S. All without exception either have visited our country in the past or hope to do so soon.

The show piece of Stockholm medical circles is Söders Hospital, a new ultramodern institution. Here the planned decentralization of laboratories has to a great extent become a reality. There are large individual laboratories where all the necessary tests can be carried out so that very little is sent to the municipal center. The work here is mostly routine diagnosis, and very little research has been done so far.

The Swedish State Bacteriological Institute is one of the most modern laboratory establishments to be found in Sweden. Opened about 12 years ago it is independent of the Swedish Medical Board and stands directly under the public health authorities. Its functions are both diagnosis and research.

The institute is headed by Prof. Olin, whose work, especially the *Salmonella* phase of it, is familiar to Americans. The permanent staff—about 25 professional persons and 200 technicians—is distributed among a diagnostic department, a virus department, a division for chemical bacteriology, an antibiotic division, and a department for the production of vaccines and serums. The latter produces most of the vaccines and sera used in middle and central Sweden. Only smallpox vaccination is compulsory, but diphtheria vaccination is available free of charge to all school children.

The equipment of the institute is modern and complete. Microscopes are exclusively binocular, of German and Swiss make; Swedish centrifuges, electrofreezers, and autoclaves are excellent and the customary workshop in the cellar can produce a large percentage of the laboratory equipment. Karolinska's library is used extensively but there is a fair stock of current journals of the bacteriological field in the institute. The electron microscopes at Karolinska are available for research, as is also the *one* at Uppsala. Here, as everywhere, plans are being completed for new buildings, especially for enlarging the virus department and facilitating more work on polio and hepatitis.

When the State Institute was built provision was made for each doctor to have adequate space for research. Since most members of the staff are affiliated as consultants with one or more of the city hospitals, cooperation and interchange of information are excellent. All the departments carry on research, to a large extent in connection with their diagnostic routine work.

So far as medical education is concerned here, conditions are quite a bit different from those prevailing in the U.S. It takes between eight and ten years to complete the course for a practicing medical degree in Sweden. Medical courses are offered in the universities, and also in the two large state medical centers, each divided into a public health department, a hospital, and a series of institutes for medical education and rsearch. One of these state centers is Karolinska (Caroline) Institute in Stockholm, where I spent several days, and where Dr. Heden and Dr. Svartz in particular were extremely kind in showing me around. Karolinska Institute is an up-to-date institution somewhat on the scale of the Columbia University-Presbyterian Medical Center in New York City. The large routine laboratory of the hospital is very well equipped and able to handle a tremendous amount of routine work per day. I was interested to see, for instance, that although Sweden has only a small amount of aureomycin and almost no chloromycetin available, sensitivity tests and body fluid levels for these drugs had already been developed and were being applied.

Of much greater interest were the individual institutions. I visited two, the Institute for Cell Research, a Nobel establishment, and the King Gustav V Research Institute. At the cell research center Dr. Malmgren and Dr. Heden are engaged in studies on the nucleotide metabolism of bacteria. The biochemistry department works with isotopes, on tuberculosis, and on the isolation and study of respiratory enzymes. Optical studies on cell composition are in progress in the large and excellently equipped optical department. This boasts an American-made electron microscope, available also to the other research institutions of Stockholm, and good modern ultraviolet apparatus. The central optical department is separated from the rest of the house by air spaces between the walls to prevent vibration, and has collapsible walls so that rooms can be rearranged according to need. The three ultraviolet microscopes are used at present to study hemoglobin synthesis. A soundproof acoustical measuring room is also found.

The King Gustav V Research Institute was built and endowed with donations by the Swedish people at the 80th birthday of King Gustav V. His Majesty desired that the institute should devote a greater part of its energies to rheumatic disease investigations. Dr. Schwartz who heads the institute, impressed me as an extremely able scientist who, through her own boundless enthusiasm, energy, and vast knowledge of the field, led and inspired her co-workers' endeavors. Rheumatic diseases are studied from the bacteriological, serological, chemical, and physiological standpoints. The chemistry department studies the body fluid protein fractions as pertaining to rheumatic diseases, that is, both blood specimen and joint exudates. Dr. Svartz told me that they had been able to verify that the ß- and γ-globulin fractions in the blood of animals injected with living pneumococci, staphylococci, and enterococci cultures showed an agglutination against red sheep cells and that investigations along this line are continuing. The department owns a Swedish-made electron microscope and I was able to convince myself of its excellence by means of several pictures of untreated and penicillin-treated typhoid bacilli which I was shown. They were extraordinarily clear, taken at a magnification of 150,000 to 190,000 times, the untreated bacteria showing a wealth of morphological detail and the treated ones tremendously elongated, the cell body thinning and emptying.

Several other minor fields of research are pursued at the King Gustav V Institute. Dr. Nieman works on substances to decrease blood pressure, there is some allergy research, and plans have been made for virus work as soon as the virus laboratory is equipped. I came away from Karolinska with my head fairly whirling with the scientific activity I had seen there.

The oldest university in Sweden is Uppsala University, founded in the late 15th century, where arts and sciences are taught to about 4000 students. The Department of Hygiene and Bacteriology, where I was the guest of its head, Prof. Löfstrom, has been in existence since 1935. The department is housed in the new Pathology Building; eventually it is planned to separate the hygiene division and turn it into a preventive medicine department, so that the Bacteriology and Virus Department can spread out a bit and add courses to its teaching program. The department now offers a six-week clinical bacteriology course for freshmen medical students but hopes soon to add an additional course for more advanced students.

Prof. Löfstrom, who had been appointed only eight months ago, was kind enough to show me about and explain the research in progress. The department consists of its director, six associates and assistants, and about 20 technicians, who do routine diagnostic work from the university hospital and also help in the research in progress. When the planned virus department materializes, poliomyelitis and bacteriophage research will be done. Prof. Löfstrom is continuing his work on immunology, his associate is working on tuberculosis in relation to sensitivity tests to a Swedish antibiotic (PAS—p-aminosalicylic acid). Future work on immunology and quantitative measurements on airborne infections seem to be the main interests of the bacteriology department director and his co-workers.

In concluding this report from Sweden I should like to thank all the doctors who extended to me the hospitality of their institutes in such generous fashion. I hope that we in America will be able to reciprocate to some extent when we shall play host to them here.

Lotte R. Weilheimer
517 East Fifth Street, New York City

Book Reviews

Isotopic tracers and nuclear radiations: With applications to biology and medicine. William E. Siri. New York-London: McGraw-Hill, 1949. Pp. xiii + 653. (Illustrated.) $12.50.

This book is a completely rewritten version of "A. F. Technical Report No. 5669," originally prepared for the Army Air Forces. It is primarily a reference book for research workers and not suited as a text for students either in content or in price. Those who expect just another book on isotopes will be pleasantly surprised to find something much superior. It contains many sections which are solidly filled with useful material, concisely presented and conveniently arranged. The complete Seaborg and Perlman table of isotopes would make a lesser book top-heavy. Its inclusion here is taken for granted.

Over half of the book is devoted to physics. Here, where one expects the usual trivia, one finds instead an extremely thorough review of basic principles of nuclear physics, including a very comprehensive treatment of the interaction of ionizing radiations with matter. The method of presentation correctly ignores the historical approach and begins with the basic factors of nuclear stability. The inclusion of a section on neutron theory is perhaps to be expected, but no discussion of reactors follows. The text is liberally sprinkled with useful graphs and tables and each chapter is concluded with many literature references. A peculiar feature is that the names of many authors are consistently misspelled.

Although Part III, on the biological and medical applications, will soon be dated, this is the difficulty which any writer on this subject faces at the present time. Many will appreciate the fine bibliography of nearly 100 pages. A certain degree of organization has been achieved in a badly cluttered field. Chapter 29, on isotopes in therapy and diagnosis, is written with laudable restraint.

A few people will feel that the book is overbalanced in favor of physics, and that the treatment of such topics as radioautographs and hot laboratory technique is thus too brief. The chapter on the theory of tracer methods is incomplete, and one misses a section on radiation chemistry. Occasional misprints are found; on page 174, F^{55} should be Fe^{55}. In spite of these points, the book will be a very useful practical tool to the investigator and will certainly be found within close reach on many desks during the next few years.

C. W. SHEPPARD

Oak Ridge National Laboratory

Scientific Book Register

DOWSON, W. J. *Manual of bacterial plant diseases.* London (W.1): A. & C. Black, 1949. Pp. viii + 183. (Illustrated.) 16s. net.

FULLER, HARRY J., and TIPPO, OSWALD. *College botany.* New York: Henry Holt, 1949. Pp. xiv + 993. (Illustrated.) $5.75.

GOODENOUGH, FLORENCE L. *Mental testing: Its history, principles, and applications.* New York: Rinehart, 1949. Pp. xix + 609. (Illustrated.) $5.00.

HALE, WILLIAM J. *Farmer victorious: Money, mart, and mother earth.* New York: Coward-McCann, 1949. Pp. xii + 241. $3.00.

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JACOBSON, C. A. (Ed.) *Encyclopedia of chemical reactions.* (Vol. III, cobalt through iridium.) New York: Reinhold, 1949. Pp. xi + 842. $12.00.

KRAMER, PAUL J. *Plant and soil water relationships.* New York: McGraw-Hill, 1949. Pp. xiii + 347. (Illustrated.) $4.50.

LAWRENCE, MERLE. *Studies in human behavior: A laboratory manual in general psychology organized to stress the basic principles of individual and group behavior with emphasis on perception.* Princeton, N. J.: Princeton Univ. Press, 1949. Pp. x + 184. (Illustrated.) $3.50.

LEVER, WALTER F. *Histopathology of the skin.* Philadelphia: J. B. Lippincott, 1949. Pp. xv + 449. (Illustrated.) $10.00.

MARTIN, JOHN H., and LEONARD, WARREN H. *Principles of field crop production.* New York: Macmillan, 1949. Pp. ix + 1176. (Illustrated.) $6.00.

MILLER, A. R. *The adsorption of gases on solids.* (Sequel to the Cambridge Physical Tract *Some problems in adsorption* by J. K. Roberts.) New York: Cambridge Univ. Press, 1949. Pp. viii + 133. (Illustrated.) $2.50.

Non-linear problems in mechanics of continua. (Proceedings of Symposia in Applied Mathematics, Vol. I.) New York: American Mathematical Society, 1949. Pp. vii + 219. (Illustrated.) $5.25.

ROBINSON, JUDITH. *Tom Cullen of Baltimore.* New York: Oxford Univ. Press, 1949. Pp. xii + 435. (Illustrated.) $3.50.

SCOTT, MERIT. *Mechanics: statics and dynamics.* New York: McGraw-Hill, 1949. Pp. xi + 394. (Illustrated.) $4.50.

NEWS and Notes

Lise Meitner, nuclear scientist, who fled from Berlin in 1938, has become a Swedish citizen. Dr. Meitner is at present conducting research at the Physics Institute of the University of Technology at Stockholm.

Albert M. Stone, special consultant to the Research and Development Board, has been appointed technical assistant to the director of the Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Maryland. Dr. Stone was formerly scientific liaison officer in the London branch of the Office of Naval Research.

Robert K. S. Lim, former surgeon-general of the Chinese Nationalist Army, has been appointed visiting research professor at the University of Illinois College of Medicine. Dr. Lim will continue his research on the gastrointestinal hormone "enterogastrone."

Willis H. McCann, clinical psychologist at State Hospital No. 2, St. Joseph, Missouri, has been appointed clinical professor of psychology at the University of Kansas City. Dr. McCann will retain his present position at the State Hospital and will teach courses in psychopathology and psychotherapy.

Bernd T. Matthias, German physicist, has been appointed an assistant professor of physics at the University of Chicago. During the winter quarter he will teach classes in elasticity and hydrodynamics. Dr. Matthias has been working on synthetic crystals at the Bell Telephone Laboratories in Murrayhill, New Jersey.

George H. T. Kimble, chairman of the Department of Geography at McGill University, Montreal, and secretary of the International Geographical Union, has been appointed director of the Council of the American Geographical Society of New York. He will assume his new duties in June, succeeding **John K. Wright,** who has resigned after 11 years as director.

Ralph W. Bost, Smith Professor of Chemistry and head of the Department of Chemistry, University of North Carolina, has been elected chairman of the American Chemical Society's Division of Organic Chemistry.

Tze-Tuan Chen was appointed associate professor of zoology at the University of Southern California, giving courses in genetics, cytology, and general zoology. He assumed his duties last September first.

M. M. Wintrobe, professor of medicine, University of Utah School of Medicine, will deliver the fourth Harvey Lecture of the current series at the New York Academy of Medicine on January 19. Dr. Wintrobe will speak on "Factors and Mechanisms in the Production of Red Corpuscles."

Horace L. Hodes, formerly associate professor of pediatrics at Johns Hopkins University and member of the staff of the Rockefeller Institute, has been named chief of pediatrics at Mount Sinai Hospital in New York City. Dr. Hodes will continue his research in infant diarrhea in the hospital's new pediatric laboratory.

George G. Brown, chairman of the Department of Chemical and Metallurgical Engineering at the University of Michigan, has been named director of the U. S. Atomic Energy Commission's Division of Engineering. Dr. Brown will join the AEC staff on a full-time basis in the spring. As director of engineering, he will be responsible for the chemical engineering phases of the AEC's reactor development program.

Visitors to U. S.

Mary Collins, of the George Combe Psychological Laboratory, University of Edinburgh, will spend the spring semester as visiting professor in the Department of Psychology at Swarthmore College.

G. L. Hammond, of the British Ministry of Supply, London, and **M. Nagaoka,** president of the Japan Optical Company, Tokyo, recently conferred with members of the National Bureau of Standards.

Joaquin V. Luco, of the Catholic University, Santiago, Chile, has been named visiting professor in physiology at the Long Island College of Medicine. Dr. Luco succeeds **Oscar Orias,** who has returned to his institute at Cordoba, Argentina.

Fellowships and Prizes

The National Foundation for Infantile Paralysis is offering postgraduate research fellowships for one to three years in the fields of virology, orthopedic surgery, pediatrics, epidemiology, and neurology. These fellowships are available to qualified candidates whose objectives are research and teaching in these fields. Eligibility requirements include U. S. citizenship, sound health, an M.D. or Ph.D. degree, two years' residency training in the specialty, and a program of study and detailed plan of investigation. Financial benefits will be arranged according to individual needs. Additional information and applications may be obtained from Professional Education Division, The National Foundation for Infantile Paralysis, 120 Broadway, New York 5.

The American Society for the Study of Sterility is offering an annual award of $1,000 known as the Ortho Award, for an essay on the result of clinical or laboratory research pertinent to the field of sterility. Competition is open to those in clinical practice as well as to those whose work is restricted to research in basic fields or to full-time teaching. The prize essay will appear on the program of the forthcoming meeting of the society, which is to be held in San Francisco on June 24 and 25. Full particulars may be obtained from Dr. Walter W. Williams, Secretary, 20 Magnolia Terrace, Springfield, Massachusetts. Essays must be in his hands by *April 1.*

Grants and Awards

The Académie des Sciences of the Institut de France has awarded the

1949 Binoux Prize in the History and Philosophy of the Sciences to J. M. D. Olmsted, professor of physiology, University of California, for his biographies of the three French physiologists, Claude Bernard, François Magendie, and Charles-Édouard Brown-Séquard.

The A. Cressy Morrison Prize of $200 was awarded this month by the New York Academy of Sciences to Harold R. Hagan of the Biology Department, College of the City of New York. Dr. Hagan won the award for his monograph "Embryology of the Viviparous Insects."

Robert Cushman Murphy, Lamont Curator of Birds, American Museum of Natural History, has been awarded the **Raimondi Medal of the Geographical Society of Lima,** in recognition of his pioneer ecological investigations in the coastal waters of Peru. Dr. Murphy's medal is for the year 1946 and constitutes his second honor from Peru. In January, 1925, he received the degree of *Doctor honoris causa* from the University of San Marcos.

The 1950 Albert Victor Bleininger Award, conferred by the Pittsburgh Section of the American Ceramic Society for "distinguished achievement in the field of ceramics," will be presented to Stuart M. Phelps, senior fellow, Mellon Institute, and director of research and tests, American Refractories Institute.

The 1949 Pittsburgh Award of the American Chemical Society's Pittsburgh Section has been presented to H. V. Churchill, chief analytical chemist of the Aluminum Company of America.

Colleges and Universities

The Massachusetts Institute of Technology recently announced receipt of industrial grants-in-aid totaling $800,000, including $250,000 from the United Fruit Company of Boston, $50,000 from an unnamed Massachusetts corporation, $250,000 from the Cities Service Research and Development Company of New York, and $250,000 from the Standard Oil Company of California.

A collection of several thousand scientific and medical books was presented this month to **Hebrew University,** Jerusalem, by the U. S. government. The books, valued at $25,000, are the first installment of a $250,000 collection to be given to the university as a perpetual loan from this country.

A Department of Biophysics has been established in the **University of Pittsburgh's Division of Research in the Natural Sciences.** The new department was made possible by a $45,000 grant-in-aid from the Sarah Mellon Scaife Foundation to the university for the purpose of expanding and stabilizing its biophysics program over a three-year period.

Columbia University's Department of Civil Engineering has received a $7,000 grant from the Research Corporation for a research program dealing with the fundamental aspects of mechanical behavior and properties of engineering materials. The investigation will be under the direction of Alfred M. Freudenthal, who has planned and directed research in the fatigue of metals in cooperation with the Office of Naval Research. William J. Krefeld, director of the school's Civil Engineering Research Laboratories, will coordinate the research program with other projects now being carried out in the department.

Cornell University Medical College and the Cornell University-New York Hospital School of Nursing will begin an experimental program in February to determine the possible reciprocal advantages of joint studies between the social sciences and medical and nursing education. The project is being carried on in cooperation with the Russell Sage Foundation and is expected to continue for a period of about two years. Leo W. Simmons, associate professor in the Department of Sociology, Yale University, has been granted leave of absence to direct the work.

Meetings and Elections

A Symposium on Dental Caries Control was presented before the recent meeting of the Association of Military Surgeons of the United States in Washington, D. C. on November 11. All aspects of tooth decay prevention were evaluated by the participants from the standpoint of their special fields of research. Rear Admiral C. V. Rault, chief of the Navy Dental Corps, presided. The first speaker, Frank J. Orland of the University of Chicago, stressed that the evidence that certain bacteria, particularly those capable of producing large quantities of lactic acid in a short time, are associated with the carious process is only circumstantial or indirect. Furthermore, direct evidence bearing on this point is needed for final proof of the etiological reationship of bacteria, such as lactobacilli, to dental caries. When the causative agents of dental caries are eventually established, only then, can antibacterial substances be used with greater specificity, and therefore effectiveness, in the prevention of tooth decay.

The next participant, Joseph F. Volker, University of Alabama, emphasized the dietary reduction of refined carbohydrates as a caries control measure. Some evidence has been accumulated to show that, among hamsters, the diet of the mother is an influencing factor upon the caries susceptibility of the molar teeth of offspring. Whether this finding has a bearing on human beings is problematical. Francis A. Arnold, Jr., of the U. S. Public Health Service, discussed the historical aspects of the findings that a low concentration of fluoride in the water intake of growing individuals can reduce the incidence of dental caries. Topically applied sodium fluoride has also been shown to be effective in animals and man, if properly applied. The Public Health Service study of the caries incidence in Grand Rapids, where one part per million of sodium fluoride has been added to the communal water supply, has not yet advanced far enough to indicate any definite trend as to caries reduction in the children examined, Arnold pointed out.

As final speaker, Basil G. Bibby, of the Eastman Dental Dispensary, stated that almost no acceptable studies had ever been made showing that brushing of teeth had any correlation with the reduction of dental decay. He mentioned the innumerable therapeutic dentifrices tried, but stressed only those containing penicillin as having some promise of success in curtailing tooth decay on the basis of studies in animals and groups of children. Discussion of these four presentations followed.

F. J. Orland

Geological Field Conference on the Mississippi River Valley. An invitational field conference on the late Cenozoic geology and geological history of the Mississippi River Valley was held June 12–25, under the auspices of the state geologists of the states concerned—Arkansas, H. B. Foxhall; Illinois, M. M. Leighton; Iowa, H. G. Hershey; Kentucky, D. J. Jones; Louisiana, L. W. Hough; Mississippi, W. C. Morse; Missouri, E. L. Clark; Tennessee, H. B. Burwell. The leaders were: for Iowa, A. C. Trowbridge and H. G. Hershey, for Illinois to Mississippi, M. M. Leighton and H. B. Willman, and for Louisiana, G. E. Murray and Leo Hough. The purpose of the conference was to enable geologists and pedologists to review together the field phenomena, beginning in southeastern Iowa and extending to south-central Louisiana.

The contrast in features of the upper and lower segments of the Mississippi River Valley has always been of outstanding interest in North American geology, but it has been recognized that despite this contrast their development has been harmoniously interrelated. Recent interpretations of the Lower Valley, however, are quite different from and incongruous with the prevailing concepts of the Upper Valley. The conference contributed substantially to a more harmonious interpretation of the valley as a whole and focused attention on problems to be further investigated.

The more important subjects given consideration were: the preglacial, high level chert gravels beneath the glacial drift in the Upper Valley and their relation to similar gravels south of the drift border; the driftsheets laid down by the various continental glaciers and the evidences of their relative ages; the succession of the loess formations and the evidences of their relative ages and origin; the valley-train terraces, especially those of Wisconsin age, and their relation to the alluvial fill of the Lower Mississippi; the evidences of the alternating character of the glacial melt waters, aggradational to torrential, and the causes therefor; and Pleistocene changes in drainage.

A total of 45 persons, most of them specialists and representing universities and state and federal surveys, participated in the conference. Geologists and pedologists found common ground in the problems considered—particularly in the alteration of sediments by weathering and soil-making processes and in the recognition of their primary origin. The significance of profiles of weathering in the determination of relative ages of the sediments impressed everyone during the course of the conference as being a matter of major importance. Failure heretofore to recognize such phenomena and their significance accounts for some of the differences in interpretation of the geological history of the valley.

The conference was probably one of the most comprehensive field conferences ever held. A similar trip in the Missouri Valley area is contemplated by the geologists of that area within a year or so.

[The authors have in preparation a paper dealing with the late Cenozoic geology of southern Illinois.]

M. M. Leighton and
H. B. Willman

A conference on the Use of Tracers in Organic Reaction Mechanism Studies will be held at Brookhaven National Laboratory January 19–20. Speakers and their topics are as follows: Thursday—*B. M. Tolbert*, University of California, Reaction Mechanism Studies Using Carbon 14: I. The Decomposition of Acetyl Peroxide in Acetic Acid (with A. Fry and M. Calvin), II. The Preparation of Demerol by Reductive Methylation and the Role of Formaldehyde and Formic Acid in this Reaction (with W. Tarpey, H. Hauptmann, and H. Rapoport); *Knut A. Krieger*, University of Pennsylvania, Mechanism of Acetylene Oxidation over Silver Nitrate; *Aksel A. Bothner-By*, Brookhaven National Laboratory, Studies using C^{13} of Natural Abundance (with J. Bigeleisen and L. Friedman); *O. Kenton Neville*, Oak Ridge National Laboratory, C^{14} Tracer Studies in the Rearrangement of α-Diketones: III. The Rearrangement of Unsymmetrical Benzils; *Robert B. Loftfield*, Harvard University, Mechanism of Faworski Reaction; Friday—*William H. Hamill*, University of Notre Dame, Primary Processes Involving Radiobromine at the Carbon-Carbon Double Bond; *Russell R. Williams, Jr.*, University of Notre Dame, The Detection and Identification of Free Radicals by Use of Radiohalogens; *John D. Roberts*, Massachusetts Institute of Technology, Rearrangements of Carbon Atoms in Alkyl Derivatives; *Elliot R. Alexander*, University of Illinois, Mechanism of Catalytic Hydrogenalysis; and *Martin Gibbs*, Brookhaven, The Mechanism of the Alkaline Degradation of Glucose. Information concerning housing and transportation may be obtained from Mrs. M. Kuper, Director's Office, Brookhaven National Laboratory, Upton, New York.

A conference on polluted irrigation waters, sponsored jointly by the Environmental Health Study Section of the National Institutes of Health, the El Paso Health Department, and the Texas State Health Department, will be held January 27 in El Paso. The program will be devoted to discussions of general problems of irrigation waters in several western and southwestern states; current research in the incidence and behavior of pathogenic organisms in irrigation waters, vegetable washings, and soils; and epidemiological aspects of sewage-polluted irrigation waters; in addition, papers will be presented on the utilizaton of waste water, impounding and use of water of the Rio Grande, machines for vegetable washing, present standards for irrigation water, and use of sewage sludges for soil improvement. Copies of the program may be obtained from Mr. Irving Gerring, Executive Secretary, Environmental Health Study Section, Division of Research Grants and Fellowships, National Institutes of Health, Bethesda 14, Maryland.

The Twelfth Annual Midwest Power Conference, sponsored by the Illinois Institute of Technology with the cooperation of 18 midwestern universities and professional societies, will be held April 5–7 at the Sherman Hotel, Chicago. The theme of the conference will be "Economy in Power."

The following officers were elected at the fifth session of the **International Union for Scientific Study of Population,** held at Geneva August 27–September 2: president, L. Hersch, Switzerland; vice presidents, D. V. Glass, United Kingdom, L. Livi, Italy, A. J. Lotka, U. S., K. B. Madhava, India, G. Mortara, Brazil, A. Sauvy, France, S. Szulc, Poland; and secretary general and treasurer, G. Mauco, France. They will serve until the next meeting of the assembly.

Charles Allen Thomas, executive vice president of the Monsanto Chemical Company, St. Louis, has been elected chairman of the Board of Directors of the American Chemical Society, to take office January 1. Dr. Thomas succeeds **Roger Adams,** chairman of the Chemistry Department of the University of Illinois and president elect of the AAAS, who has served three consecutive terms as director, the maximum term permitted by the society's constitution.

Deaths

William Alexandre Perlzweig, professor of biochemistry and chairman of the department at Duke University, died of cancer on December 10. Dr. Perlzweig, who was 58 at the time of his death, had made extensive studies of the metabolism of the vitamins of the B complex. He was a special adviser to Hebrew University Hadassah Medical School, Jerusalem.

Arthur Parker Hitchens, 72, Commissioner of Health in Wilmington, Delaware from 1945 to 1948, and former George S. Pepper Professor of Preventive Medicine at the University of Pennsylvania, died at his home in Philadelphia on December 10. As a member of the Research Board of the U. S. Medical Department in Manila, 1924–25, Dr. Hitchens participated in the organization of the School of Public Health and Preventive Medicine at the University of the Philippines.

Samuel R. Haythorn, pathologist and director of the William H. Singer Research Laboratory at Allegheny General Hospital in Pittsburgh, died on December 6 at the age of 69. Dr. Haythorn, who was formerly head of the Department of Pathology and Bacteriology at the University of Pittsburgh, was known for his research in tuberculosis, silicosis, and cancer.

A health protection clinic, where anyone over 18 years of age may receive free tests for detecting disease or disability in early stages, will be opened in Boston on January 3. It is the first of five such clinics, located in pivotal areas throughout the state, to be sponsored by the Massachusetts Medical Society with the cooperation of the Massachusetts Department of Public Health and voluntary agencies. Claire F. Ryder, epidemiologist with the State Health Department, has been appointed administrator. The cost of the clinic for a six-month period is estimated at $30,000, of which the U. S. Public Health Service will supply $15,000 for clinic personnel and the Massachusetts Department of Public Health will provide $12,000. The balance will come from voluntary agencies, of which the American Cancer Society will donate $1,250.

Radioisotopes may now be obtained under the Canadian export program. The Isotopes Division of the U. S. Atomic Energy Commission has been named the coordinating agency for the import of Canadian radioisotopes, as it is for the domestic distribution and export of U. S.-produced isotopes. Applications may be made to the division, P. O. Box E, Oak Ridge, Tennessee.

Recently Received—

Recent Developments in Hawaiian Land Utilization. E. O. Kraemer. Paper No. 51. University of Hawaii, Honolulu, T. H.

How to Collect and Preserve Insects. H. H. Ross. Circ. 39, Illinois State Natural History Survey, Urbana, Illinois.

Preserving Birds for Study. Emmet R. Blake. Fieldiana: Technique No. 7. Chicago Natural History Museum.

Effects of Oil Mixed with Carbonized Sand on Aquatic Animals. Special Scientific Report: Fisheries No. 1. Fish and Wildlife Service, U. S. Department of Interior, Washington 25, D. C.

National Academy of Sciences Biographical Memoirs, Vol. XXV. National Academy of Sciences, Washington, D. C.

Recommended Nutrient Allowances for Horses. No. VI, Recommended Nutrient Allowances for Domestic Animals. Committee on Animal Nutrition, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

Short Periodic Solar Variations and the Temperatures of Washington and New York. C. G. Abbot. Smithsonian Miscellaneous Collections, Vol. 111, No. 13, Publ. 3990. Smithsonian Institution, Washington, D. C.

The Quest for Stellar Parallax. Dorrit Hoffleit. Harvard reprint 321. Harvard Observatory, Cambridge, Massachusetts.

The Standard Cepheid Light Curve. Harlow Shapley. Harvard Reprint 29, Series II. Harvard Observatory, Cambridge, Massachusetts.

The Birefringent Filter. John W. Evans. Harvard reprint 30. Harvard Observatory, Cambridge, Massachusetts.

The Black Rock Forest Twenty-Year Progress Report, 1928–48. Bull. No. 14. Henry H. Tryon and Raymond F. Finn. Cornwall-on-the-Hudson, New York.

Government Support of Research

Alan T. Waterman

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IT IS INTERESTING and significant to find government support of research so much under discussion recently. It is interesting because there has been for the past few years a great deal more support from government, and therefore at least the edge of the need has been dulled. It is interesting also because, contrary to the attitude before and immediately after the war, there are few institutions now that are unwilling to entertain the idea of government support. It is significant because we are now in the position, not only of establishing the need for support of research, but also of considering how much support is necessary and prudent and how it should be provided. The value of discussion at the present time lies in the fact that we are now able to evaluate what has been accomplished, at least to some extent, and thus more realistically to consider plans or proposals for the future.

The subject "Government Support of Research" as considered here is limited to support by the federal government to scientific research outside its own establishments. No attempt will be made to discuss support of research by state and city governments, which is a different kind of problem.

It is hardly necessary to review the reasons for government support of research. It may be recalled that before the war there was little or no interest in support of general basic research by the federal government, although there was demand for support in particular areas of research and to some extent for general and higher education. Nevertheless, awareness of need for support had its origin at that time in the concern with which educational and industrial institutions viewed lack of capital, low returns from investments, rising taxes, and hard times generally. But there were few then who advocated federal support.

It is probably salutary to recall that, historically, research has always required a patron; it has never been regarded as self-supporting. We have become so accustomed to the idea of pure research conducted in universities that we tend to forget this fact. Actually, the universities have become the patrons. Research foundations, which operate more frankly in the older tradition, and certain industries have to some extent also assumed this role. If the funds from these sources begin to fail or the demand for research increases it is not surprising to find a search for ways to add to the traditional means of support. As a matter of fact, both conditions have been operative.

This parasitic view of research should not be regarded as humiliating; it puts research in the class with the creative arts, along with literature, music, painting, and sculpture. It may be that the time will come when it is generally realized that pure scientific research does in fact more than pay its way. Certainly a strong case can be made. But we should be careful not to fall into the error of assuming that great discoveries can be bought or that research in certain fields will never be profitable. I doubt whether any such practical justification of pure science will ever come about through the efforts of scientists themselves. There will always be too many among us who regard with apprehension or resentment the motivation of utility. This is probably as it should be, but we must admit that it is a source of misunderstanding when we ask for money.

Much has been said and written of the effect of the war on the need for scientific research. It is true that we drew heavily on our stockpile of scientific knowledge. It is true that most European science, which had long led us in fundamental research, came to a standstill. But other factors were also at work. Academic scientists learned what industry already knew—the advantages of teamwork on scientific problems. Also, notably in nuclear physics and fluid mechanics, large scale and costly installations proved necessary, but beyond the reach of single institutions. We must add to this the urge among many of the scientific fraternity to return to the pursuit of knowledge with a deep sigh of relief after their strenuous years of applied research and development.

It was in this atmosphere that a National Science Foundation was proposed. There are many who feel it a misfortune that the first bill for a National Science Foundation and those subsequently proposed have failed of enactment. However, it is some consolation to realize that we all now know a lot more about the problem than we did, both as a result of the discussion provoked by rival legislation and as a result of experience with such federal support as has been available. This at least is good, and should be helpful in making a National Science Foundation more effective if established.

In the atmosphere just following the war it is not surprising that the military establishment took the lead in sponsorship of research. Everyone was convinced of the importance of science, and research in particular, to national defense. In 1946 General Eisenhower put forth a strong statement to this effect, and the Navy went into action by securing authorization for a special Office of Naval Research, through farsighted planning led by such men as Robert D. Conrad, Luis de Florez, Harold Bowen, and James Forrestal. It was necessary for the military to act quickly, since their peacetime plans had to be made at once and geared to a much lower level of operation. Besides, many felt that much of the Office of Scientific Research and Development had permanent value and should be retained. In this connection it is interesting to note a statement made in 1885 by the then Secretary of the Navy, William C. Whitney:

> The rapid advance of the art of naval warfare and the singular fertility of human genius in devising new and more formidable implements of destruction are rendering this branch of public service more complicated and difficult. . . .
>
> A naval vessel at the present moment is a product of science. Taking the world over it will be found that each part of her—her armor, her armament, her power, and the distribution of her parts or characteristics—each of these features of the completed vessel is absorbing *from year to year* the exclusive study *of a class of* scientific men. And as men of science throughout the world are continually stimulated to new discoveries and inventions, no vessel that can be built can be considered a finality in any particular.
>
> It is of little service to a nation to have any Navy at all unless it is a fair expression of the highest scientific resources of its day. The destructive power of the modern implements has become so great as to dominate in actual warfare. The bravest and best commander is helpless without them.

Just how broad is the need for support of research? Does industry require or want government support of research? Should *all* colleges aim to do a fair proportion of research? If so, should all receive government support? If not, to which should support go? Should support be given to the institution as a whole, to particular schools or departments, or to qualified or promising individuals? Or should it be on a different basis—support in certain fields of apparent promise or of interest to the donor? Whatever the answer, one has to reckon with the fact of limited government appropriations for the purpose.

And what of the problem of scientific manpower? If we grant the desirability or even the urgency of increased support of research, have we actually an adequate number of scientists and engineers for the job we need to do? It is commonly supposed that we have not, and that no considerable expansion in support of research can be started at once without serious dislocation of existing programs. But this statement is only partly true, and, like all part-truths, can prove a serious obstacle to proper action. It is true that the need for competent scientists in industry and in government is great and that the available supply is low, and the same can be said with even more force with respect to the teaching of science at the more elementary levels. But the operations of the ONR have produced conclusive evidence that there is still abundant room for support of research in colleges and universities, and this may take place with little if any detriment to existing programs for combined research and development. Furthermore, by application of increased support along this avenue we should at the same time take the most direct step toward alleviation of the shortage of highly trained scientific manpower, This research is almost entirely basic in character, and is, consequently, universal in availability to all. Although assistance in this direction could not be counted on to produce immediate practical benefits, the by-products would in many cases lead to important applications. From straight content alone, the outcome would merely add to our store of scientific knowledge. But ideas beget ideas and we should thereby greatly enhance the likelihood of turning up untold treasures, still in the rough.

One may properly ask how it is possible that this situation may exist—an unfilled demand for research scientists and yet an unfilled capacity for accomplishment of research. The answer is evidently that there are many competent scientists who prefer the academic environment and who cannot be induced to leave it. Among them are good research scientists who can, with help of a graduate student or two and funds for equipment and materials, turn out good research without interfering seriously with their present share of educational work.

One consequence of the support now provided is an expressed need by the heads of educational institutions for general funds to restore the balance disturbed by support in special fields.

Questions like these should really be considered by a general agency like the proposed National Science Foundation, or, failing that, by a special commission if the matter is urgent enough. There are other matters, too, which should be more the concern of such an agency than any existing one, such as support of fellowships, underwriting scientific publications, dissemination of scientific information, exchange of scientists, aid to foreign science, and finally, firsthand scientific advice to the executive and the legislative branches of the government.

These are some of the reasons why the ONR should not be regarded as a competitor of the proposed National Science Foundation. For purposes of our present discussion, the function of the ONR is to follow and coordinate the research performed by the rest of the Navy and to supplement this by support of research externally and within its two major field laboratories, the Naval Research Laboratory and the Special Devices Center. The ONR interprets this part of its function as justification for backing a limited program of basic research in scientific areas which offer the chance of ultimate important effect upon developments in weapons, devices, and techniques of warfare.

There are other advantages too. As stated by a former chairman, Detlev W. Bronk, of our Naval Research Advisory Committee:

> We feel that there are many important practical needs of the Navy which derive from fundamental research which cannot be immediately identified. We also have faith that there are very important results which are going to issue from research undertakings which cannot, at this present moment, be identified as having outstanding practical value; secondly, we feel that it is of great importance to the Navy that there should be outstanding civilian scientists who are associated with the Navy through their ONR contracts. We feel this is a source of good will, expert advice, and guidance, and one which would not be as available to the Navy if there were not these direct contractual relationships between the Navy and scientists; and finally, we feel that it would be extremely undesirable if all of the support for fundamental research were to be derived from just one agency. This is necessarily a type of support which involves exploration, adventure, and gambling and we think it is sounder, as a basis of operation, if the support be derived from various individuals and various agencies concerned.
>
> And furthermore, related to this there will be special needs of different agencies which will be best supported if all of the research support is not derived from just one foundation or one organization.

The ONR research program has been built by selection of research projects proposed by scientists with the endorsement of their institutions. This selection is based upon many factors, such as the scientific value of the research, the capability of the proposing group and their facilities, the degree of support by the institution, both financial and policywise, the probability of ultimate usefulness to the Navy, the relation of the research to that elsewhere in the Department of Defense, and last but not least, the state of the budget. The ONR grants no fellowships, it constructs no buildings for its contractors, nor does it give grants-in-aid. Its means of furnishing support is by nonprofit contracts with the institutions concerned. Much care and thought have been spent on setting up procedures which would leave the investigators free to attack their proposed research in their own way. Supervision by the government, necessary by law, takes the form of close supervision of the program, with the help of consulting panels of experts in each field of research, supervision projectwise over expenditures, and full discussion and decision in the case of change in aim or scope of a project. Almost all this external research with universities is free from security classification. Publication in scientific journals is encouraged, as are conferences and symposia. The ONR reserves the right, however, to discuss immediately any result which requires classification and to obtain agreement to remove the classified portion to some military laboratory or set up adequate safeguards in case the university and the Navy jointly wish to continue the work in the existing location.

Why is federal support of research a problem? There are three standard answers to this question: government support implies government control, it involves administrative red tape and confusion, it is erratic and uncertain. These objections must be met by such safeguards as can be managed in the arrangement set up.

At the risk of oversimplification, let me suggest that for our immediate purpose, federal support of research is a problem for two main reasons, which may be illustrated by two additional questions:

1. Is federal support of research justified? The government requires a satisfactory answer to this.

2. What will be the consequences of extensive federal support? The answer to this is a matter of concern to science, to scientists, and to scientific and educational institutions.

To the former of these two questions the majority of scientists would probably answer that federal support of research is justified provided the values inherent in the traditional environment of research, such as continuity, initiative, and freedom of communication and publication, can be maintained. In other words, most scientists would give an affirmative answer to the former question provided the answers to the latter may be satisfactory.

Let us remind ourselves at this point that Uncle Sam is properly a realist. He may believe in charitable donations for some of the people all the time, for all the people some of the time, but not for all the people all the time. In general he expects to pay only for services rendered. Thus the federal government does not provide financial support unless a need can be established, and when such support is provided it must be expected to show some return to the taxpayer.

As a quick answer to our first question, then, intelligent support of research should be able to accomplish the following:

1. Raise the productive level of research, with the many attendant benefits sure to follow;

2. Increase the output of young research men and women and thus fill the needs of industry, government, and academic institutions.

But let me turn at once to my second question: What may we expect to be the consequences of extensive federal support of research? As mentioned earlier, I shall consider only the case of support in institutions external to the government, and especially in nonprofit institutions such as universities, technical institutions, and colleges. I shall confine my remarks to support given on broad, comprehensive lines, and so not mention the support furnished by agencies with special fields in view—as for example the excellent work done by such agencies as the Public Health Service and the Department of Agriculture.

In the first place, if we are to be realistic we must at once admit that extensive government support of research will have consequences beyond the important and beneficial ones of stimulating research output and supply of future scientists. It is a commonly observed fact that any attempt to change some factor in a situation is accompanied by effects other than those intended. Indeed experimental science knows that it is only by careful planning and painstaking attention to techniques that these spurious effects may be kept in the background.

For one thing, increased support of research in universities has been accompanied by an increased number of graduate students. What effect will this have upon the quality of the doctor's or graduate engineer's degree? It may be that by increasing graduate school enrollments we shall succeed in turning out no larger number of potential research leaders but shall actually lower the average competence of the total output, by dilution and by congestion. Perhaps increased demand for trained research men and women and for research administrators may to some extent justify such a tendency, but the situation should be watched.

Research institutions generally are apprehensive of possible dictation or control over their research by a supporting agency. The independence of an institution is threatened if pressure can be applied toward the acceptance of undesired work. This may be minimized by the policy of basing support on proposals initiated from the institution, by the avoidance of permanent construction owned by the supporting agency, and by a cooperative program of joint support. For a given institution, any danger of control may be balanced to some extent by internal adjustment and by the existence of a number of sources of support. Objectionable control with respect to progress on individual problems can certainly be avoided by intelligent management. Nevertheless, even though no pressure is intended, it is undeniably true that the mere selection of research for support by an outside agency is itself a form of control.

A subtle form of this influence may be expected to manifest itself in varying degrees by the tendency of an existing research group to perpetuate support from the same source, and the attempt of other groups to slant their program in the direction of probable areas of support. This tendency should be recognized and any instances identified both by the institution and by the supporting agency.

A prospect may exist, especially among universities, which is of more fundamental concern to the cause of basic research. As already mentioned, the government quite properly invests its money in areas which will bring a return to the taxpayer—that is, in activities which promote the national welfare or security. This implies an emphasis upon short-term tangible and practical results, and this is foreign to the nature of pure or basic research. Will we therefore see in government support a verification of the truth first pointed out by Vannevar Bush in "Science—The Endless Frontier," that applied research tends to drive out basic? This would indeed be tragic. All the elements that go to make up our high standard of living, in fact a very large part of the world's thought and progress, have come about through pure or basic research in the broad sense, that is, creative work in the arts and sciences. The great discoveries cannot in general be predicted nor can they be made to order. There is no need to give examples—history is eloquent on this score. This is admittedly a troublesome point. I believe it must be met by an insistence upon support of basic research in its own right. If a practical justification is required, let us call it a necessary investment for the future. It will be dangerous for basic research to compete for funds with applied research and development, which can cite probable practical accomplishments. This difficulty might be handled in the federal budget by general agreement that every agency should have a limited sum or a limited fraction of its budget set aside for research, and that this sum should not require detailed budget defense in advance. Instead, the results of the research program should be subject to periodic review.

A quite different consequence of support of research by contract follows from the amount of administrative detail required of the institution and the supporting agency. Many academic institutions, not accustomed to this degree of administrative detail, have found it advisable to set up a special office and staff for research administration, particularly where there is a considerable volume of industry- and government-supported research. This is of course an advantage in that it takes many administrative details off the shoulders of the chief investigators and the scientific departments concerned. It is obviously important to centralize this function within the institution. The growth and strengthening of these administrative offices is a consequence of support by contract. However, there is an aspect of this development which may bear watching, namely, the possible tendency of a strong administrative office to dominate the research program of the institution. In fact, an aggressive office is in position to exercise pressure upon the research staff of the institution itself. Or it may tend to insulate the scientist from his opposite number in the supporting agency.

Another movement, which may be related to the one just mentioned, is the establishment or the strengthening of research institutes or foundations, attached to a university but separated to a greater or less degree from the academic or educational plant. Such organizational units have advantages from the standpoint of handling externally supported contracts and of increasing the research business of the institutions. They can accept support for applied research or development with less fear of upsetting the balance between education, basic research, and applied research. They can more readily go in for group research and more extensive programs. To some extent they can protect the university from sudden fluctuations in financial support. They can more readily accommodate confidential work, either from industry or government. But such a unit may run into rather troublesome situations, such as a salary differential between its staff and faculty members not connected with it. For another thing, if it goes in strongly for applied research and development and is ready to accept projects upon request, it may come into competition with commercial research agencies. This competition may be regarded as unfair if the unit takes advantage of its nonprofit and tax-exempt status to quote lower costs for research or development undertaken. It is of course early to say, but it is possible that, unless great care is exercised, the advantages gained by this separation of research from education may be offset by deterioration in fundamental research.

These are some of the consequences which may be anticipated from government support of research. They are of course bound up with the mission of the sponsoring agency and also the policy and procedures established by this agency. These are to a certain extent dictated by governmental limitations, both as to allowable procedures and as to mission. In this connection, I should like to return to a point mentioned earlier, namely, the importance of a government agency's having the authority and opportunity to pursue basic research. Let me illustrate by the case of the ONR as a typical example. This office has as its aim the sponsorship of research for the Navy Department. Since the Navy's mission is national defense, it is clear that the money spent by the department should be directly related to national security. Insofar as national security implies scientific strength in the country as a whole there is justification for wide support of science, provided the country's science is felt to require assistance. This was admittedly the case immediately following the war. The question then arises whether the department should continue to give widespread support to science if and when a stage shall have been reached of a strong, stable scientific effort in the nation. It is the considered judgment of the ONR—and this is fully endorsed by its Naval Research Advisory Committee—that the Department of the Navy is still justified in continuing support of basic research in outside institutions, provided the level of this operation is definitely limited and is appropriate to Navy needs. The reasons for the interest of the ONR in basic research may be expressed as follows: The Navy's interest lies in end results, whether weapons, devices, or techniques; very many of such end items have their origin in science. Now, progress toward these end items occurs in the following sequence: basic research, applied research, development, test, and production. Note that this chain of events begins with basic research. This beginning may be found in scientific literature or in current research.

One of the most promising avenues toward accomplishment, then, is to expedite this sequence. Sometimes progress may be held up for lack of basic research; again there is apt to be serious delay between the basic research stage and that of applied research, or between the development and production. The ONR conceives as one of its most important functions the speeding up of the research end of this sequence. Any progress along this road can be an untold asset for national security. It should be clear that real effectiveness in such a mission can be accomplished only when the agency concerned has responsibility for support of basic research, for quickly seeing promising applications and for assistance in initiating appropriate action within its department. In the long run this job cannot be handled adequately if left entirely to some other agency. This was a mistake made by the military establishment prior to World War II. It is certainly true that a second-hand method of providing this service is also second-best, and this is hardly justifiable when we are dealing with national security. The case is, in fact, quite similar to that of the technical industries, which have long recognized the necessity of supporting research.

It should not be forgotten that there are areas in basic research which are of the greatest importance to a particular agency such as the Department of Defense or the Department of Commerce, but where no general research agency like a National Science Foundation would be expected to provide adequate support. In these areas the government department can hardly expect adequate and timely support from a foundation where the work has to compete with the latter's own mission and with outside requests. Furthermore, at any given time specific areas in basic research can be identified as bottlenecks to existing developmental programs. Again the operating agency critically needs authority to pursue these on its own initiative. Quite apart from these considerations, it is my personal belief that no one should question the right of an operating agency to place a limited fraction of its support in extremely pure or fundamental research in the major fields of science. This appears to me completely justifiable in many ways. For example, there is the opportunity of uncovering a radically new discovery of significance chiefly to the agency, ties are thus established by the agency with up-to-date scientific thinking, barriers between science in government and outside science are destroyed, the morale of scientists at work for the agency is improved, and competition in pure research serves as a stimulus. Finally, I believe it is the opinion of most scientists that research should never become the monopoly of any agency, government or otherwise.

I have remarked earlier that the government expects practical results from the support of research, and that in basic research the investigator should be as free as possible to work out his ideas. These ideas usually have nothing to do with possible application, and in fact any practical consequences are generally regarded as irrelevant to the investigation. How are we to reconcile these apparently opposing points of view? The answer is clear. In general, we must consider the practical application of ideas from basic research to be the responsibility of the supporting agency and not that of the investigator. This recognizes a well-known fact that many research men have no particular aptitude for applied research or, if they have, do not make use of this aptitude except in solving their own research problems. Thus a research investigator may show a high degree of ingenuity in devising a piece of his apparatus to perform a special, practical function, but he regards this ability as important only to the accomplishment of his main purpose, the solution of his problem. If his attention to his chosen goal is deflected the probability of his making a creative contribution is considerably reduced. It is the integrated total of such accomplishments that form the backbone of true scientific progress.

On the other hand, the supporting agency should choose its staff to include scientists of a more practical turn of mind who by association with the needs of the agency are in the best possible position to spot possible applications and to carry them forward in the hands of the proper group in their department. If this policy is followed, there should be minimum difficulty in insuring proper environment for the sponsored research and, at the same time, satisfactory output of practical suggestions. What is more, the tendency toward improper pressure on the research worker or his institution is eased thereby.

In order to arrive at adequate safeguards to insure reasonably effective operation of external research programs supported by a government agency, it may be profitable, at least for purposes of discussion, to attempt to lay down a few guiding principles. I propose the following:

1. In selection of items for support, emphasis should be placed upon the field of interest of the agency and upon the caliber of the investigator, with final selection made from specific problems proposed by interested research scientists and accompanied by endorsement of their institutions.

2. Every effort should be made to insure that the working conditions are appropriate to research. These mean freedom in performance of research and freedom to publish and to exchange information with colleagues.

3. Administrative details should be handled as fully as possible by the respective administrative staffs of the institution and the supporting agency. However, the initial arrangements and any subsequent changes should be reviewed by the interested scientists on both sides.

4. The supporting agency should possess a scientific staff with full authority regarding approval of research projects and it should have committees of experts to guide it in formulation of its program.

5. The scientific staff of the supporting agency should be composed of scientists with research experience who know from personal background the conditions that should be maintained. This staff should be competent to discuss the work intelligently and intimately with the working research groups. It should also be competent administratively and organizationwise to deal effectively with administrative and service units in the agency and also with other agencies with which the work should be coordinated.

While the success of any plan for government support of research obviously depends on the administration of the supporting agency, it must at all times be remembered that no charter, no administrative setup, and no staff can succeed in this relatively unchartered area without full cooperation from the institutions supported. It is impossible to solve many questions on a unilateral basis. A common misapprehension is that administrative questions arising in a research program may be solved apart from scientific matters or vice versa. In point of fact, the two are apt to be inextricably mingled. In the negotiation and administration of supported research there are and should be four groups involved: the research group at the institution, the scientific staff of the agency, and the administrative offices of both the institution and the agency. It is also desirable that the policy of the supporting agency be flexible enough to adjust to the policy of the institution, within limits. Above all, I wish to emphasize the great importance of a cooperative interest on the part of the research investigators in the program supported by the government agency. This cooperation should be kept extremely close, in order that the agency may meet or even anticipate the needs of the research group, and in order that it may plan effectively. A successfully organized program should have the weight of approval of all its constituents. If this is achieved, government support of research will be abundantly justified.

Technical Papers

Fluorometric Determination of Serum Aureomycin Levels

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In view of the difficulties associated with the bacteriologic assay of serum aureomycin concentrations, a method was developed of determining these concentrations by adsorbing the aureomycin on small columns of silica gel and observing the yellow fluorescence at the top of the column. A fluorometric method of measuring high concentrations of aureomycin has been reported by Kelsey and Goldman (*1*), but their procedure is not applicable to determining the low concentrations found in clinical material.

It was observed that aureomycin had an intense yellow fluorescence in an acid or neutral medium and that after several minutes in an alkaline medium it began to be altered to a compound with a blue fluorescence. Inasmuch as yellow fluorescing compounds are a great deal more uncommon in body fluids and among medications than blue fluorescing compounds, it was felt that a test depending on yellow fluorescence would be less subject to interference than one depending on blue fluorescence. Hence, only neutral solutions were used.

Two-hundred-mesh activated silica gel (Davison) was backwashed with distilled water at 100 ml/min on a column 50 mm × 1 m for 3 hr. This removed the very small particles and gave a suspension of particles of fairly uniform size. To a 20-cm length of 6-mm glass tubing constricted at one end and packed with glass wool, there was added, by means of a capillary pipette, enough of a slurry of the prepared silica gel to form a packed column 3 cm long. Packing was achieved by repeated tapping of the column until no further settling occurred. One ml of serum containing aureomycin was allowed to filter through the silica gel column without vacuum or pressure being applied. The serum was followed by 1 ml of isotonic saline and 1 ml of 95 or 100% ethyl alcohol. The saline served to wash out the serum, and the alcohol intensified the fluorescence. At no time was the surface of the silica gel column allowed to dry out or be mechanically disturbed by the addition of fluids. Standards were prepared, in the same manner, with sera to which 20, 10, 5, 3, 2, 1, 0.5, 0.2, and 0.1 μg of aureomycin hydrochloride[2] had been added. The aureomycin was diluted to the appropriate concentration in distilled water and 0.1 ml of the dilution added to 0.9 ml of serum. The unknowns were visually compared to the standards, after dark adaptation, in a darkened room with the focused light from an 85-watt argon-mercury lamp filtered to remove all wavelengths above 400 mμ. The fluorescence appeared at the top of the column as a yellow band, which varied in width and intensity according to the concentration of aureomycin. Standards must be prepared every day or two, since the fluorescent color tends to fade. The success of this procedure depends in large measure on obtaining uniform silica gel particles and in uniformly packing these particles into a column free of bubbles.

The procedure may be modified to determine aureomycin in urine, spinal fluid, and other media. These modifications and the preparation of permanent standards will be reported elsewhere.

The fluorometric test was checked against bacteriologically determined levels on two healthy subjects who took, respectively, 9.3 and 10.4 mg/kg of aureomycin orally, and on patients who had received a single intravenous dose of aureomycin. The results are recorded in Table 1.

A test for interfering substances was made by adding aureomycin to the sera[3] of patients receiving other medications. Patients with jaundice, cirrhosis of the liver, leukemia, arteriosclerosis, rheumatic fever, acute pneumonia, and other conditions were included in this test.

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[1] The authors wish to thank Dr. Eleanor Bliss, of The Johns Hopkins Medical School, for her stimulating suggestions and encouragement.

[2] The aureomycin hydrochloride used in these experiments was supplied by the Lederle Laboratories Division of American Cyanamid Company, through the Antibiotics Study Section of the National Institutes of Health.

[3] These sera were obtained through the kind cooperation of the members of the House Staff of The Johns Hopkins Hospital.

TABLE 1

A COMPARISON OF FLUOROMETRIC AND BACTERIOLOGIC METHODS OF DETERMINING SERUM AUREOMYCIN CONCENTRATIONS

Patient	Aureomycin dosage	Time after administering dosage	Fluorometric levels μg/ml	Bacteriologic levels μg/ml
C. W.	9.3 mg/kg	Control*	0	0
	orally	1 hr	1	0
		2 hr	4	2.5
		4 hr	5	2.5
		6 hr	4	1.25
		8 hr	3	1.25
		12 hr	1	0.3
		24 hr	0.2	0
J. W.	10.4 mg/kg	Control*	0	0
	orally	1 hr	1.3	0
		2 hr	1.7	0
		4 hr	3	2.5
		6 hr	2	1.25
		8 hr	3	1.25
		24 hr	0.5	0
W.	200 mg	Control*	0	0†
	I. V.	75 min	3	2†
R.	200 mg	Control	0	0†
	I. V.	80 min	2	0.5†
B. W.	?	75 min	1	1†
	I. V.			
B. R.	?	30 min	1	0.5†
M. W.	200 mg	Control*	0	0†
	I. V.	5 min	15	10†
		15 min	3	1.25†
		30 min	3	1†
		60 min	2.5	1†

* Control tests were performed on patient's sera before aureomycin dosage.

† These bacteriological levels were performed by Dr. Caroline A. Chandler of The Johns Hopkins Medical School.

They had received a variety of medications including sulfa drugs, penicillin, dicumarol, salicylates, and vitamins. In addition, streptomycin and chloramphenicol were each added to a serum containing aureomycin. In no case was anything found which interfered with the fluorometric test.

In the few determinations reported, there is a general correlation between the fluorometric and bacteriological assays. The fluorometric test appears to give slightly higher readings than the bacteriologic test. This suggests that the fluorometric test is measuring not only aureomycin but, in addition, something which is closely allied to and associated with aureomycin and which is bacteriologically inactive. Efforts are being made to define further the accuracy of the fluorometric test.

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Preparation of C^{14} Uniformly Labeled Fructose by Means of Photosynthesis and Paper Chromatography[1]

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The common carbohydrates, glucose, fructose, sucrose, and starch have been labeled with C^{14} by allowing leaves to photosynthesize in the presence of $C^{14}O_2$. However, only glucose, sucrose, and starch have been prepared with sufficient purity and activity to permit their use in tracer experiments. Fructose has not been available for tracer work because of the difficulty in separating it from glucose following sucrose hydrolysis. Putman *et al.* (*5*) used the calcium-fructose complex methods as described by Bates and associates (*1*). This method has two disadvantages: large amounts of carrier fructose are added, yielding a product of very low specific activity; and the fructose still contains appreciable amounts of glucose.

Recently Partridge (*4*) applied paper chromatography to the qualitative analysis of reducing sugars. The separation of glucose from fructose on a one-dimensional chromatogram using phenol as the solvent is very good (R_f glucose – 0.39, R_f fructose – 0.51). A 1-in. strip of paper can be used to separate as much as 0.3 mg of fructose from a similar amount of glucose. By using several strips of paper, we have prepared in very pure form milligram amounts of highly active fructose.

After four trifoliate bean leaves had been allowed to photosynthesize in the presence of 2.8 mc of $C^{14}O_2$ (*3*), they were killed in hot 80% alcohol. This alcohol extract contains sucrose, glucose, and fructose as well as other alcohol-soluble substances. After ether extraction and passage through ion exchange columns (Amberlite 100-H and Duolite A-4) to remove polar compounds, H_2SO_4 was added to make the solution 1 *N* and it was kept at 80° C for 10 min. After hydrolysis, the sample was again passed through the ion exchange columns to remove the acid. Most of the glucose was crystallized from the mixture by the addition of carrier glucose followed by the addition of alcohol.

To separate the fructose from the glucose still remaining in the mother liquor, 75 chromatograms (14 × 1.5-in. strips of Whatman No. 1 filter paper) were set up with 0.1–0.3 mg of sugar per strip. After development with phenol, the strips were air-dried and placed on x-ray plates (Eastman Type K). It is evident from Fig. 1 that a radioautograph of each strip is necessary, since the bands are not always in the same position. In about 2 hr the radioautographs were dark enough to permit tracing of the outlines of the bands onto the chromatograms. The outlined fructose bands were cut out and pooled, giving a total of about 2 g of filter paper. About

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[1] Research carried out at Brookhaven National Laboratory under the auspices of the Atomic Energy Commission.

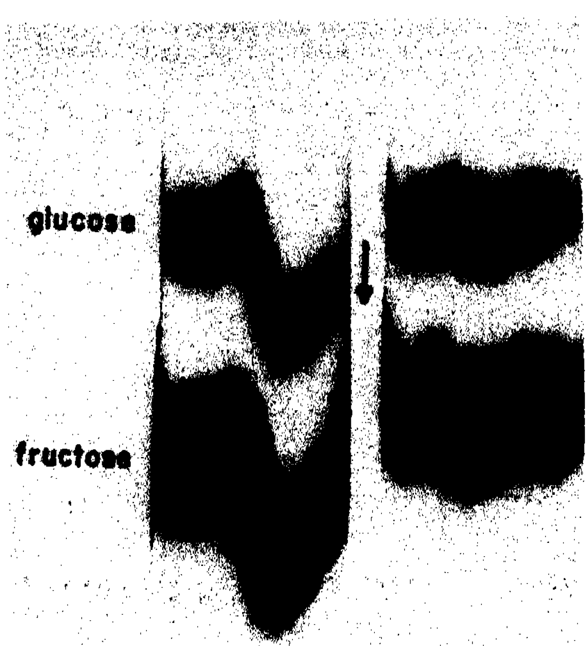

FIG. 1. Radioautograph of chromatogram of glucose and fructose.

10 mg of fructose was eluted from the paper by boiling the paper with 80% alcohol, followed by Soxhlet extraction for 5 hr. The alcohol was removed by vacuum distillation, water being added from time to time. The aqueous solution was extracted with ether to remove traces of phenol. To remove other impurities, the solution was passed through ion exchange columns (Amberlite 100-H and Duolite A-4) with 30 mg of carrier fructose added. The resultant solution (about 300 ml) was concentrated at 35° C to a small volume and finally concentrated to a syrup in a vacuum oven at 35° C.

The syrup was crystallized as described by Putman *et al.* (*5*). Thirty mg of fructose was added during the crystallization. Since the amount of fructose was small, it was found convenient to carry out the crystallization steps in a centrifuge tube and to collect the fructose by centrifuging in a refrigerated centrifuge. The purity of the fructose was determined by paper chromatography, using as solvent butanol and water saturated with propionic acid (*2*). Only one band was found. The final product had a specific activity of 1.2 mc/mg of fructose. A portion of the fructose was degraded by the microbiological method of Wood, Lifson, and Lorber (*6*) and found to be uniformly labeled.

Many groups of compounds other than sugars—for example, amino acids, peptides, and carboxylic acids—can be subjected to chromatography on paper in milligram quantities. This large capacity and the simplicity of the technique make paper chromatography valuable for the isolation of such compounds as well as for their assay.

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A Megalonyx Tooth from the Northwest Territories, Canada

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Among a miscellaneous collection of fossils submitted by Galen B. Smith to the junior author for identification, there was one specimen which deserves special attention. It was a tooth of a ground sloth, and according to Mr. Smith was obtained at Lower Carp Lake, north of Great Slave Lake in the Yellowknife region.[1] It was associated with fragments of a mastodon tooth. The specimen was sent to the senior author for detailed study.

The tooth (No. 15208, Academy of Natural Sciences, Philadelphia—Fig. 1a,b), is like the second lower cheek tooth of *Megalonyx* in shape and straightness of crown. It also resembles in cross section the second upper cheek tooth in this genus. While the wearing surface of the tooth is somewhat abraded, the features which result directly from its occlusion with opposing teeth can be ob-

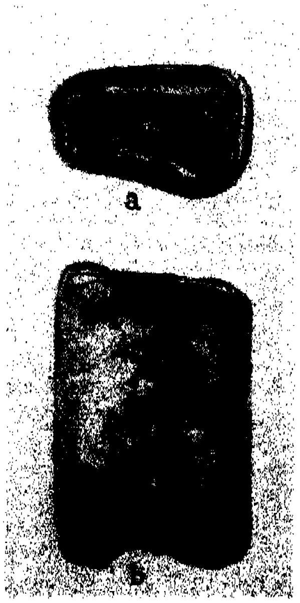

FIG. 1. *Megalonyx* cf. *jeffersonii* (Desmarest). Lower cheek tooth, No. 15208 Academy of Natural Sciences, Philadelphia. (a) Occlusal view; (b) anterior (?) view. Natural size. Pleistocene, Yellowknife region, Northwest Territory, Canada.

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[1] 63° 35′ N; 114° 10′ W. See Rae sheet (85 NW-NE) National Topographic Series of Canada.

served, and these are similar to the characters noted in the second lower cheek tooth. The specimen resembles, but may be slightly smaller than, the comparable tooth of *Megalonyx jeffersonii*. Dimensions, in mm, of the Academy of Natural Science's No. 15208 are: transverse diam 25.9; anteroposterior diam 17.7.

Interest in the specimen arises largely from its occurrence so far north on the American continent. In 1942, Stock (*2*) reported the occurrence of a ground sloth at a locality 15 miles southwest of Fairbanks, Alaska. This identification was based on a phalanx, representing apparently a species of *Megalonyx*. The tooth from north of Great Slave Lake is the second occurrence of the ground sloth *Megalonyx* to be noted in the northwestern region of North America, but the locality is considerably east of Fairbanks, Alaska.

The Yellowknife specimen is undoubtedly of Pleistocene Age, although its exact position within the Pleistocene is uncertain. It is perhaps not surprising to find the genus ranging this far north during Pleistocene time, in view of its usual association with forest faunas. The Yellowknife and Fairbanks specimens are the only two records of a ground sloth north of the United States-Canadian boundary. These specimens may date from the warm phase of postglacial time, or they may be older and date from an interglacial stage. An interglacial age of some of the Quaternary mammals from Alaska has been suggested by Johnston (*1*).

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Infrared Spectrometry of Small Samples with the Reflecting Microscope

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It has been shown (*1*) that the usefulness of infrared spectrometry may be extended through the application of the Burch (*2*) reflecting microscope. As this microscope is a custom-built instrument available only at Oxford, we investigated the possibility of using American reflecting microscopes in connection with infrared spectrometry.

The Bausch and Lomb Optical Company's Grey design Type V apochromatic reflecting microscope condenser and objective of 0.72 NA (*3*) were placed at our disposal, through the courtesy of Mr. L. V. Foster of that company, for tests in the infrared region of the spectrum. From the standpoint of infrared spectrometry these units are not as useful as totally reflecting systems because of their limited frequency range (from the ultraviolet to 2500 cm^{-1}) imposed by the inclusion of refractive and infrared absorptive elements. It was possible, however, to obtain infrared spectra from the visible region to the carbon dioxide absorption near 2400 cm^{-1}, using samples of microscopic size.

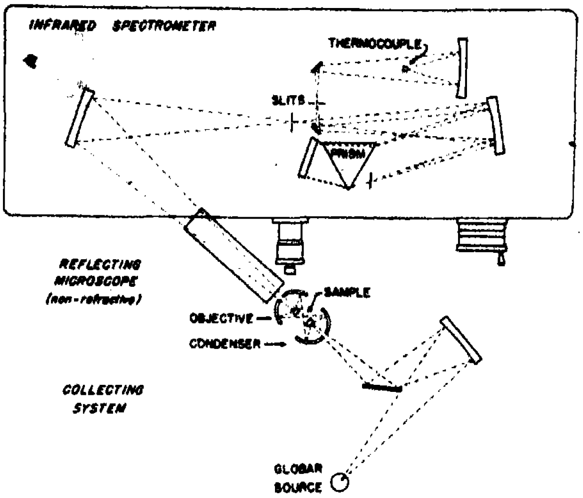

FIG. 1.

The promise shown by this study made it desirable to investigate the utility of the Bausch and Lomb Grey design, Type IV, 0.4 NA condenser and objectives (*3*). This design includes only reflecting elements. One model existed at the time of this investigation, and it was owned and operated by the Polaroid Corporation; its loan was made possible through the great courtesy of Dr. E. R. Blout of the Research Laboratories of that company and Prof. E. G. Rochow of Harvard, who kindly and carefully transported the microscope to and from Stamford.

It was not possible to introduce obvious optical refinements into the system because of the shortness of the time of trial, so the microscope was added to the optical system of a Perkin-Elmer model 12B infrared spectrometer, as shown in Fig. 1. An auxiliary Globar source collected the radiation and focused it into the reflecting condensing system. The focused radiation, after passage through the sample, was collected by the objective. The condenser and objective were mounted on a standard microscope which had been turned on its back. Any microscope equipped with a swinging stand for horizontal photography, or the Bausch and Lomb Type DDE, could be used (if the large reflecting optics would fit). The radiation emerging from the draw tube, without the use of an ocular system, was collected by the first spheroidal mirror of the spectrometer. This mirror then focused the enlarged image of the specimen onto the entrance slit. The physical dimensions were adjusted so that the diameter of this image was equal to the length of the slit.

The portion of the image of the specimen subtended by the entrance slit could be controlled by adjustment of the specimen on the mechanical stage of the microscope. The sample could be suspended in mineral oil on a rock salt plate or between plates, according to the customary infrared technique, placed in solution, or attached to a stretched fine wire by lightly greasing the wire with mineral oil. From the weight of a crystal suspended on the wire, the area of the specimen image on the slit, and the area of the slit it was possible to estimate the mass of the sample under observation. Inasmuch as the slit width must be increased as the wavelength is increased because of the black-body characteristics of the radiation source, the estimated mass of an observed sample varied from 0.3 µg at 4,000 cm^{-1} to 3 µg at 650 cm^{-1}.

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[1] The author wishes to acknowledge the interest and help of Dr. T. G. Rochow and Mr. E. J. Thomas of the Microscopical Department of the Stamford Research Laboratories.

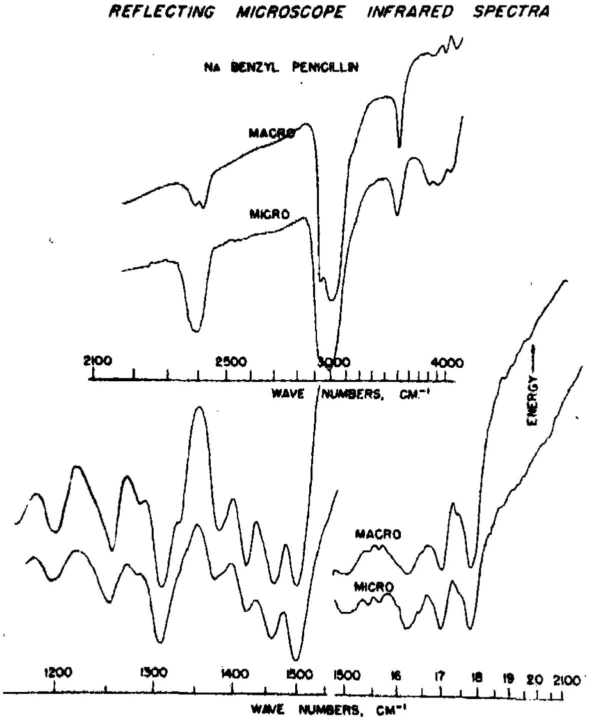

FIG. 2.

A portion of the spectrometer recordings on macro and micro size samples of sodium benzyl penicillin are shown in Fig. 2. The effect on resolution of the wider-than-usual slit widths necessary with the microscope is observable near 2400 and 1325 cm^{-1}. The micro sample recording was made with an amplification of the thermocouple output such that 0.3 µv gave a full-scale deflection of the Brown recorder. More careful adjustment of the optical system should enable the use of smaller slit widths and less amplification.

It is obvious that the use of such totally reflecting microscope systems in connection with infrared spectrometers should permit large reductions in sample size with attendant increased applications in the biological and crystal structure fields.

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A Method for the Study of Blood Loss in Hookworm Infestation[1]

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Leichtenstern (*7*) pointed out in 1886 that the hookworm (*Ancylostoma duodenale*) was an avid consumer of blood. In 1909 Whipple (*9*) made the same observation in this species as well as in *Necator americanus*. In 1931 Wells (*8*) reported a series of observations involving *Ancylostoma caninum* while the parasites were attached to the intestinal mucosa of living dogs indicating, without a doubt, that this parasite was able to withdraw enough blood per day to account for the anemia often found associated with hookworm infestation. Work done by Cruz in Brazil, and by Rhoads and Castle and their associates in Puerto Rico has materially contributed to our knowledge of this parasitic disease. Wells (*8*) states that there is a possibility that a single worm may withdraw as much as 0.8 ml of blood in 24 hr but that there is apparently a considerable amount of variation in the activity of individual worms.

We present here a pair of preliminary studies of the average rate of blood loss in moderately infested dogs. These studies were carried out in order to determine the feasibility of the method of approach used, with the intention of extending it to a study of human hookworm infestation at a later date.

Two healthy adult mongrel dogs, 2-G and 1-J, were used in these studies. They had both been kept at an anemic level of blood hemoglobin for many months by frequent controlled hemorrhages and their reserve stores of iron were therefore depleted. At the time of application of the larvae the dogs' red cell hematocrits were 24% and 25%, respectively. About 2,000 infective larvae of *Ancylostoma caninum* suspended in saline were applied to each animal, contact being made between the toes and on the groin, where the body hair was sparse. The animals were fed a diet consisting of white bread, Klim, salmon, and cod liver oil in order to restrict iron intake (*6*), and were housed in cages with perforated metal floors. After a period of 5–6 weeks several examinations of feces showed numerous ova of the parasite. One of the dogs, 1-J, earlier had severe diarrhea, accompanied by the excretion of a moderate amount of mucus and red blood.

Four weeks following application of the larvae each animal received by vein 100 ml of blood from a donor dog. This latter animal had previously been fed large quantities of radioactive iron while anemic in order to build up red cells containing tagged iron in the hemoglobin iron (*5*). Immediately after, the diet was again allowed to consist of hospital table scraps so there was no exogenous deficiency of iron.

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[1] This work was supported by a grant from the Nutrition Foundation.

Blood was collected in isotonic sodium oxalate and centrifuged at about 2,800 rpm in a type 2 International centrifuge for 35 min. The plasma was decanted and discarded. The red cells were wet ashed and their contained iron was separated by precipitation, electroplated, and examined for radioactivity content (*2*). Correction was made for decay of the isotope and for removal of the tagged iron by blood sampling as described elsewhere (*4*).

When administered by mouth to an anemic iron-depleted dog, the radioactive isotope of iron will in part be absorbed and this fraction will be incorporated for the most part in the red blood cell hemoglobin, very little being stored in other tissues. The level of the tagged iron in the red cells remains quite constant over many months, provided there is no loss by bleeding (*4*). If there is destruction of cells due to aging or hemolysis, the liberated iron is promptly reutilized to form new hemoglobin with the restoration of the original level of isotope in the circulating red cells (*4*). When the red cell isotope levels of the two dogs infested with hookworm were plotted they showed a regular drop, which appeared to be logarithmic. Plotted on semilogarithmic paper, this was borne out in the case of Dog 1-J. However, with Dog 2-G there seemed to be two periods in which the rate of blood loss was somewhat different.

In order to determine the rate of blood loss from the curves we may set up the following relations. For the sake of simplicity we shall consider only the part of the isotope curve which corresponds to the period where the hematocrit level was reasonably constant. It has been pointed out that under conditions allowing sufficient time for establishment of equilibrium in the circulation, the red cell mass is approximately a linear function of the jugular hematocrit (*3*). During the time in which there was no marked change in the hematocrit level, there was a nearly constant red cell mass in the circulation. Thus the rate of regeneration of red cells approximately equaled the rate at which they were lost to the circulation by the blood-sucking activities of the *Ancylostoma*. This may be expressed:

$$dv \xrightarrow{\qquad\qquad} \frac{N}{V} \xrightarrow{\qquad\qquad} dv$$

where v is the increment of red cell mass regenerated or lost in *ml*, N is the amount of radioactivity expressed in cpm, and V is the mass of red cells in the animal's circulation. Then

$$dN = N/V \cdot dv$$

Transposing and integrating between proper limits:

$$\int_{N_o}^{N} dN\,/N = 1/V \qquad \int_{O}^{v} dv$$

or $\ln \frac{N}{N_o} = \frac{v}{V}$ (provided there is perfect mixing, which we are justified in assuming because of the time relations involved in the experiment). Since the concentration of radioactivity in the red cells is shown by

$$C = N/V \text{ and } C_o = N_o/V:$$

then $v = V \ln N/N_o = V \ln \frac{C}{C_o}$

or $\frac{N}{N_o} = C\,\frac{-v}{V}$.

If we take $v = V$, then $N/N_o = 1/e = 0.37$, i.e., if outflow equals the original red cell mass, the isotope concentration is 37% of its original value.

Applying this to the data on Dog 1-J we find that the initial activity was 2,000 cpm/100 ml of red cells. Then $0.37 \times N = 740$ cpm/100 ml red cells. This value for isotope level was found after 27 days. Applying the same procedure to Dog 2-G, we find the red cell mass equivalent to that originally present was lost in 16 days.

Based on body weight and hematocrits (*5*), these dogs had estimated red cell masses of 250 ml (2-G) and 275 ml (1-J). Roughly, this would indicate total blood volumes of about 1 l each. The data indicate that it required only 16 to 27 days for the loss of this amount of blood in these animals due to the proclivities of the hookworm, the animals at the same time maintaining relatively constant hematocrits. This rate of blood loss and regeneration is compatible in each case with the approximate amounts of blood it was found necessary to remove from these animals in order to maintain fairly constant hematocrits in similar periods of study prior to these experiments.

Loss of blood through hemorrhage by any route also lends itself to study by this method. It would perhaps be more direct and accurate to measure the radioactive iron in the excreta in this and any other similar type of investigation, but this is sometimes not convenient. Such direct measurements would not be subject to the difficulties encountered in total iron analyses, since the presence of interfering materials in chemical analyses may be eliminated in making the radioactivity determinations.

The use of donor tagged red cells might be questioned since their introduction has been used to study the survival time of red cells in hosts. However, in the relatively iron-free anemic dog, when the red cells disintegrate due to age or trauma, the liberated tagged iron is very rapidly reincorporated into new cells without grossly affecting the level of the isotope in the red cells (*4*). The inconvenience of preparation of such donor animals may be obviated by feeding a single dose of tagged iron to the infested subject and allowing that part which is absorbed to be synthesized by the body into hemoglobin. This method would lend itself to studies of human hookworms, especially where it was inconvenient to prepare donors. It would only require in addition to the described method that one wait until the isotope had reached a constant value in the peripheral circulation, or about 10 days.

Counts were made of ova in these dog's feces on several occasions, but it was felt that the relative variability in the degree of hydration of the stools rendered it improbable that a reliable estimate of the true worm burden was made by using these counts.

However, if the extent of blood loss were followed, employing the method herein described, for a definite period of time, and a vermifuge were then administered and the recovered worms counted, one might determine an average value for the amount of blood consumed per day per recovered worm. Thus:

Let B = total radioactivity in excreta.
C = concentration of radioactivity in red cells.
W = total worms.
D = total days.

$$L = \left(\frac{\text{Average loss of red cells}}{\text{worm}}\right)/\text{day}.$$

Then

$$L = \frac{B}{CWD}.$$

The fact that very little iron derived from red blood cell hemoglobin is normally excreted in feces would probably make it unnecessary to correct this formula by a determination of the base line fecal iron output after vermifugation.

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Prevention of Dietary Fatty Livers by Exposure to a Cold Environment[1]

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In studies of the lesions which develop due to a deficiency of the lipotropic factors, it has been shown on numerous occasions that the development of fatty livers or of hemorrhagic kidneys is closely linked to caloric intake and to metabolic requirements. Severe lesions are more easily produced when growth is rapid and when food intake is high. Inanition may protect the liver and kidneys of an animal subsisting on a deficient diet. In an environment one or two degrees above freezing, the caloric requirement is increased greatly, as indicated by increased oxygen consumption and increased food intake. When rats weighing more than 150 g are exposed to such an environment they usually survive and some growth occurs, but at a slower rate than normal.

Two groups of ten male rats (Wistar strain), bred locally and weighing from 170 to 200 g, were given a diet ad libitum which permitted good growth but was deficient in choline and its precursors. One group was exposed to a temperature of 2.5 ± 1° C for a period of two weeks, while the other was maintained for the same period under similar conditions but at a temperature of 25 ± 2° C. At the end of the two-week period the animals were sacrificed, and their livers were examined chemically and histologically.

As might be expected, the fat content of the livers of the control group was high, averaging 24.8 ± 4.90% (total lipid expressed as % of wet weight). The average value found in the group maintained at 2.5° C was 7.2 ± 1.24%. The average weight of the livers was approximately the same, but the weights of dry fat-free residues of the livers of rats kept in the cold environment were significantly higher than those of the control group. Although rats in the cold room ate more (average 22 g/day) than the controls kept at room temperature (average 15 g/day), their increase in body weight was less (average 1.3 g/day) than that of the control group (average 3.5 g/day).

The prevention of excessive deposition of fat in the liver in spite of increased consumption of a severely hypolipotropic diet would seem to be associated with the greatly increased total metabolic rate. The results of further study of this finding may throw light on the mechanism of action of choline, and perhaps on intermediary metabolic pathways which may be affected by exposure to a cold environment.

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[1] These experiments form part of a project supported by a grant from the Defence Research Board of Canada. We are indebted to Prof. C. H. Best for his continued interest, and to Drs. Jessie Ridout and Jean Patterson for the estimations of liver lipids.

Films from Hemicellulose Acetates[1]

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Up to the present time, cellulose has been the only plant polysaccharide which has been acetylated for the production of commercial films and fibers. Commercially, hemicelluloses are separated from their natural mixture with cellulose and are regarded as undesirable impurities in pulp destined for esterification. Yet the major proportion of the hemicellulose mixture present in plants consists of xylan, a linear polysaccharide which should produce strong films. Consequently, an investigation was undertaken to obtain further information on the film-forming characteristics of hemicellulose acetates.

The hemicelluloses are sometimes isolated from crude plant material by extraction with alkaline solutions. However, lignin interferes, not only because it retards complete solution of the hemicelluloses, but also because some of it dissolves in the extract, causing difficulty in purifying hemicelluloses. These disadvantages are avoided largely through selective removal of lignin with a maximum retention of unchanged polysaccharides. Such delignified pulps are termed holocellulose (*6*).

The corncob is a typical example of hemicellulose-rich material. Approximately 80% of the corncob consists of polysaccharide material, one-half of which is cellulose, whereas the remainder is made up of a mixture of hemicelluloses. The entire polysaccharide mixture or holocellulose can be prepared by a modification (*5*) of the usual sodium chlorite procedure (*5*). Practically all of the hemicelluloses may be removed from holocellulose by extraction with a 10% solution of NaOH. Analyses indicate that the residue is almost pure α-cellulose.

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[1] Contribution by Department of Agricultural Chemistry, Purdue University Agricultural Experiment Station, Journal Paper No. 401.

Neutralization of the alkaline hemicellulose solution causes precipitation of the higher molecular weight polysaccharides and leaves in solution most of the glycuronans and polysaccharides of comparatively low molecular weight. The precipitated material is called hemicellulose A. Most of the soluble material remaining in the neutral solution is precipitated by the addition of two volumes of alcohol and is called hemicellulose B (*2*).

Results in this laboratory show that practically all of hemicellulose A consists of xylan. The mixture contains only 3% of combined hexuronic acid anhydride. Hemicellulose A, 25% of the total holocellulose, can be esterified with acetic anhydride in the presence of 0.25% of nitric acid (*4*) to produce a white fibrous acetate containing 38.6% of acetyl groups (calculated for diacetyl xylan, 39.8%). The acetate is soluble in dioxane, pyridine, or in a chloroform-methanol 9:1 mixture. When the acetate is cast from any of these solvents, clear films are produced which show an average tensile strength of 7.2 kg/mm² when measured on a Scott IP-4 inclined-plane serigraph. Films from commercial cellulose triacetate, when prepared in a similar manner, have a tensile strength of 8.6 kg/mm². Films cast from solutions of mixtures of hemicellulose A acetate and cellulose triacetate are clear and strong provided that incorporation of hemicellulose A acetate does not exceed 50%. Larger amounts of hemicellulose A acetate produce cloudy films.

Hemicellulose B, 6% of which is glycuronan material, may be esterified easily by a mixture of acetic anhydride and pyridine, provided that it is first swelled in formamide (*1*). The resulting acetate is a light brown, powdery material having an acetyl content of 35.0%. When cast from a chloroform solution, it produces clear films having a tensile strength of 7.5 kg/mm². While films can be produced by mixing hemicellulose B acetate with either cellulose acetate or hemicellulose A acetate, they are all cloudy, indicating the immiscibility of hemicellulose B acetate with either of the other two acetates.

These results show that the presence of hemicellulose A acetates does not have an adverse effect on the production of clear films of high quality. It is only the hemicellulose B acetates and possibly other low molecular weight polysaccharides that are responsible for cloudy films. The hemicellulose B fraction is present in most plant tissues in small quantities only. It represents approximately 10% of corncob holocellulose. It may be easily and completely removed through short extraction with alkaline solutions of 1–2% concentration. The residue obtained from corncob holocellulose after such an extraction may be acetylated and cast into good films.

These observations suggest the desirability of revising pulping techniques in order to retain more of the higher molecular weight hemicellulose fraction and thereby permit the use of these hemicelluloses, which are now discarded in commercial practice.

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A Possible Explanation of Symptom Formation in Tobacco with Frenching and Mineral Deficiencies

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Studies with Maryland Medium Broadleaf tobacco seedlings in aseptic culture (*3, 4*) have disclosed that slight excesses of amino acids in the medium led to the formation of characteristic growth abnormalities and chloroses. The symptoms of toxicity covered a wide range but were specific for each amino acid. Admixtures in some cases led to appearance of new abnormalities. Most effective was L(−)-hydroxyproline (3 ppm), the seedlings being killed at 5 ppm. A close approximation of the extreme symptoms of frenching was produced with the natural amino acid, L(+)-isoleucine (100 ppm); the unnatural isomer being relatively ineffective. These growth abnormalities included inhibition of stem and branch elongation, accelerated development of the leaves in the axillary buds, and reticular chlorosis of newly expanded leaves, together with greatly reduced leaf laminae ("strap leaves"). Increased leaf number was a prominent feature.

Similar responses to amino acids have now been obtained with tobacco plants growing in water-culture and soil. Frenching of oriental Xanthi tobacco was obtained with DL-isoleucine at 20 ppm in water-culture. Partially sterilized soil required very large quantities, however, in order to produce the symptoms of frenching in Connecticut Broadleaf and Xanthi tobacco.

Large scale analytical studies with field plants of Maryland Medium Broadleaf tobacco have afforded some confirmation of the interpretation that excessive accumulation of free amino acids in the plant may be a primary cause of symptom formation in certain abnormalities. Free amino acids in leaf laminae of mildly frenched plants increased to a maximum of 121% above normal. J. L. Stokes of Merck and Company estimated the corresponding increase for L(+)-isoleucine to be 50%. Free amino acids in leaf laminae of plants showing symptoms of mineral deficiencies increased with nitrogen deficiency by 32%; phosphorus, 48%; potassium, 587%; calcium, 120%; magnesium, 283%; and boron, 27%. These values are maxima. They confirm and extend the data of mineral deficiency studies with green plants (*1, 2*).

The increases in free amino acids are considered to be evidence that these chemical elements participate in protein metabolism, and that formation of symptoms is primarily due to the localized action of excessively accumulated normal metabolites. Growth responses and chloroses with amino acids are of sufficient variety to include many of the individual symptoms comprising the syndromes displayed with mineral deficiencies. Except possibly for magnesium, breakdown of chlorophyll in mineral deficiency is, therefore, not necessarily indicative of mineral participation in chlorophyll formation, as has often been assumed. The probable participation of the chemical elements in the enzymes regulating protein metabolism warrants the exercise of caution in associating specific mineral deficiencies with physiological processes in the plant. Drastic interference in the basic function of the plant should cause a breakdown in all physiological processes at varying rates.

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Annual Variation in Nicotine Content of Tobacco

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In connection with the change in nicotine content during fermentation of cigar leaf tobacco of the Pennsylvania Seedleaf variety, Frankenburg (*1*) has given data for crops of four different years. This percentage is given before and after "sweat" by the manufacturer, which is usually referred to as "final forced fermentation." In addition to reduction in nicotine content during this stage, there is a reduction in the curing by the farmer before the manufacturer purchases the tobacco. Then there is reduction during storage fermentation by the manufacturer before the tobacco is put into final forced fermentation. In our laboratory, tobacco, as received by the manfacturer from the farmer after shed-curing, has been analyzed for alkaloids routinely for a period of more than 20 years. Table 1 shows the variation from year to year over that period.

The data in the table for the years 1936, 1938, 1939, and 1941 are somewhat higher than those reported by Frankenburg for the same years. This is to be expected, inasmuch as the data were obtained with tobaccos as received from the farmers, so there was no loss from any processing by the manufacturer.

The results include nor-nicotine and other alkaloids which are present in trace amounts and for that reason the percentage is reported as total alkaloids. Each year's crop represents an average of tobaccos grown by about 100 different farmers. Five leaves were taken from each of three hands distributed throughout one bundle from each farmer's tobacco. The leaves from all these locations were ground and mixed to produce a uniform sample. By quartering, a final representative sample was obtained for analysis.

TABLE 1

ALKALOIDS IN TOBACCO AFTER CURING

Crop	Total alkaloids (oven-dried basis)	pH
	%	
1927	3.1	..
1928	2.8	..
1929	4.6	..
1930	6.0	5.8
1931	3.8	6.9
1932	5.0	5.2
1933	2.5	5.8
1934	3.0	7.3
1935	4.5	6.5
1936	4.3	6.4
1938	3.1	..
1939	3.0	..
1940	3.2	6.2
1941	4.1	5.4
1942	3.1	6.7
1943	5.0	6.2
1944	3.6	6.5
1945	2.8	6.8
1946	2.9	6.5
1947	4.2	6.3
1948	3.15	6.5

In addition to the representative sample for each year's crop, individual farmers' tobaccos have been analyzed. It has been found that from farmer to farmer there is variation in any given year, with some tobaccos having as little as half of the average for the year and others as much as 50% more. However, normally over 90% of the individual farmers' tobaccos do not vary more than about ± 10% from the average for the year. This uniformity is to be expected, inasmuch as the tobacco represents only that grown in the general vicinity of Lancaster, Pennsylvania. Where variations do occur, they represent differences from field to field, depending upon the soil, fertilizer, seed, and variations in rainfall occurring between the time of early and late harvesting of crops by different farmers. There is no relation between pH and alkaloid content.

Plotting the average alkaloid content for the various years against the amount of rainfall during the growing season shows a definite trend of higher alkaloid content in tobaccos grown in dry seasons. By breaking this down into months, it is found that the influence of rainfall on the alkaloid content is somewhat greater towards the end of the growing season, as the time of harvest approaches.

As a further point of interest, individual crops have been followed through complete manufacturing operations, including all fermentation. The average amount of alkaloid reduction is about 40%, all based on oven-dried samples. In certain extreme conditions, this may be as little as 20%, or as much as 80% reduction. This amount of reduction may be controlled and generally it is kept close to the average percentage mentioned.

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Simplified Preparative Electrophoresis at Room Temperature[1]

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Many attempts have been made to adapt the separation of electrically charged ions like proteins to simple equipment operable at room temperature. Membranes, sand barriers, gels, and jellies have been used to immobilize the material and thus prevent convection from mixing the protein in a solution, P, with the adjacent buffer solution, B. Tiselius (*1*) points out that aside from optical observations his method increases the potential gradient in the U-tube without undesirable heat convection, simplifies sampling, and avoids disturbing electrolytic processes.

The equipment for the preparative method described here costs less than $50. It suitably embodies the advantages of the Tiselius method just mentioned, and is especially adaptable for use at room temperature without any temperature control. The technique employs a modification of the classical U-tube with large side vessels for electrodes (carbons or reversible electrodes). Tail-hole stopcocks are used for withdrawing samples at the side, or a two-way stopcock at the bottom of the U-tube is employed for forming the boundary and draining the electrophoretically purified fractions from either side of the U-tube. The method depends upon controlling solutions B and P so that they will have different densities, viscosities, pH's, and conductances as follows: solution B (supernatant) will have a high coefficient of viscosity at the pH of the isoelectric point of the protein contained in solution P, to be immobilized in the lower part of the U-tube; solution B will have a density considerably less than solution P, so that as the boundary P-B is formed, a well-defined boundary, stable enough for preparative electrophoresis results. Typical solutions used by the writer and his co-workers (*2*) for the past year for the separation of trifidin and artefolin (*1*), the unpigmented fractions of giant and dwarf ragweed extracts, have been: B = 40% glycerol at pH 6.8; P = 50% glycerol extract of ragweed pollen. The electrical conductance of solutions B and P in the separation should be regulated so that as little electrolyte as convenient is in P, with a suitable amount in B, to control the pH and drop in potential at the beginning of the separation. For example, in the case of ragweed extracts, no saline was added to the ragweed to be fractionated in solution P. The 40% glycerol in B contained M/15 phosphate buffer at pH 6.8. Thus initially the main drop in potential was across the material to be separated and fractionation was facilitated. A striking experiment demonstrating this technique may be made by having solution B at about pH 6.8 employing M/15 phosphate buffer in 40% glycerine, with solution P, a mixture of hemoglobin and T-1824 (a negatively charged dye), in 50% glycerine. At this pH, the isoelectric point of hemoglobin is electrophoretically fixed at the boundaries, whereas the dye T-1824 migrates out of the mixture to the anode, leaving the hemoglobin with a fairly sharp boundary at the negative side after 24 hr.

It may be emphasized that our method utilizes Newtonian or truly viscous liquids. The convection ordinarily resulting from the application of 450 volts to a U-tube, 60 cm long with an internal diameter of 1.0 cm, at room temperature is avoided by the use of only high viscosities, not plasticities. No membranes, jellies, or similar mechanical devices are required. The temperature in the laboratories at Cold Spring Harbor during the summer of 1948 varied considerably over 24 hr but did not disturb the boundaries for preparative purposes during 4-day electrophoretic separations. The apparatus can be readily used in an ice chest. If room temperature does not destroy the material to be studied, it is preferable not only because of simplicity but also because the mobilities are greater at this temperature.

TABLE 1

Comparison of Formation of Classical Tiselius Boundaries and Those of the Modified Technique

Tiselius method	Method reported herein
Conductance B* = conductance P†	Conductance B >> conductance P
Viscosity B = viscosity P	Viscosity B < viscosity P
Density B = or slightly less than P	Density B < density P
pH of B = pH of P	The pH of B at or close to isoelectric point of protein to be separated in solution P
Temperature controlled at or near 4° C	Room temperature fluctuations—no temperature control

* Supernatant solution.
† Lower protein solution. Note that both P and B have Newtonian flow.

Table 1 summarizes the differences in preparative procedures with the classical method of Tiselius and the method herein described.

The fractionation experiments based upon this technique will soon be reported in detail (*2*). The early experiments were done with C. Reiter and M. Loebl.

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[1] Aided in part by a grant from Josiah Macy Jr. Foundation.

[2] Present address: 133 East 58th Street, New York City.

Comments and Communications

Natural Vegetation in the Willamette Valley

The letter from J. E. Smith on "Natural Vegetation in the Willamette Valley, Oregon" (*Science*, 1949, 109, 42) clearly points out the need for historical records in ecological studies. In the Nisqually River drainage area south of the city of Tacoma, Washington, the vegetation type map shows extensive areas of young Douglas fir forest. Much of this originally was prairie grassland, according to records of the early settlers. In less than a century the prairies have changed to forest, after rather heavy grazing by domestic livestock. Previously the prairie was only lightly grazed by game animals, and occasional flash fires kept the brush and conifers out.

To the southwest, below Tenino, lies the section of this old prairie country in which the Mima mounds thickly dot the landscape. Numerous interesting theories to account for their formation have been put forth. They have been attributed to eddy currents at the time the area was submerged beneath Puget Sound, to surface erosion under peculiar conditions, to the work of Indian tribes, to ant hills, to glacial action, etc. Victor B. Scheffer, in "The Mystery of the Mima Mounds" (*The Scientific Monthly*, 1947, 65, 283), proposes the theory that they were built by families or colonies of pocket gophers. While his evidence is indirect, he makes a reasonable development. Proponents of the glacier action source hold that no gopher ever carried big stones uphill, and point to the presence of rounded stones and boulders in the upper parts of the mounds. And so it goes. Here a geologically long historical record is needed to settle the matter.

Sometimes reconstructions from fossil records tell the story. R. W. Chaney brings this out very nicely in *Ancient forests of Oregon: A study of earth history in Western America.* Recent ecological studies by other scientists show the present stage of vegetation; the paleobotanical studies demonstrate its development. Ecology, to explain its present findings properly, generally must depend on indisputable interpretation of related evidence from the past.

Portland, Oregon W. E. Bullard

Thermal Coefficient of the Refractive Index of Water

A recent technical paper by Antonoff and Conan (*Science*, 1949, 109, 255) reports a discontinuity in the thermal expansion coefficient of water near 50.5° C. We have been measuring, by a direct method (Hawkes, J. B. and Astheimer, R. W., *J. Opt. Soc. Amer.*, 1948, 38, 617), the thermal coefficient of the index of refraction of water up to 53° C. Continuous observation (i.e. fringe counting) is inherent in the method, so that we have left no unobserved points in this neighborhood.

The well-known relation between refractive index and density,

$$P = \frac{1}{d}\left[\frac{n^2-1}{n^2+2}\right],$$

can be used to interpret the results for the density, found by Antonoff and Conan, in terms of the thermal coefficient of the index, which we have measured. Results are given in Table 1, with P (above) as 0.20616 cgs units.

TABLE 1

T (°C)	Estimated from Antonoff & Conan		Observed
	$\frac{d(d)}{dT} \times 10^4$	$\frac{dn}{dT} \times 10^4$	$\frac{dn}{dT} \times 10^4$
49	−4.9	−1.80	−1.64
50	−5.7	−2.09	−1.66
	−6.0	−2.20	
50.5			−1.67
	−3.0	−1.10	
51	−3.6	−1.32	−1.68
52	−4.4	−1.61	−1.70

These values are plotted in Fig. 1. The Antonoff and Conan values are estimated from their published curve; those of Hawkes and Astheimer by observations.

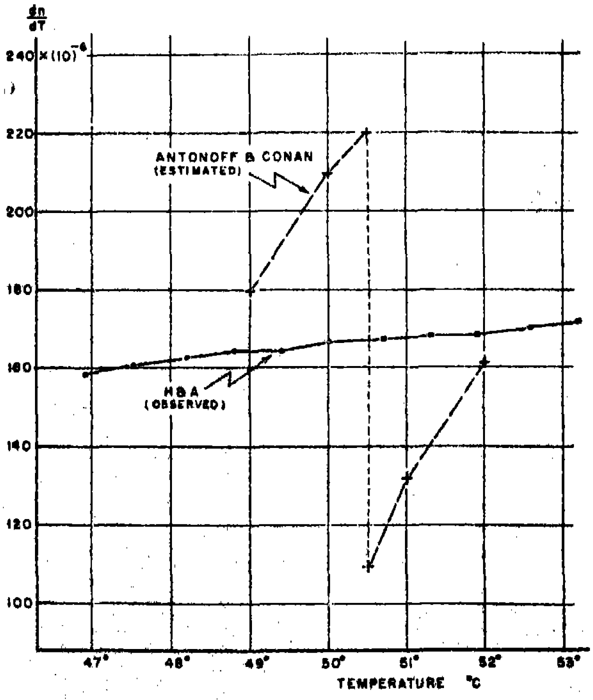

FIG. 1.

If the density of water does behave with temperature as reported by Antonoff and Conan, and if our results on the thermal coefficient of the refractive index are correct, there must be a precisely compensating discontinuity in the value of the Lorentz constant, P, at 50.5° C.

John B. Hawkes and Robert W. Astheimer

Stevens Institute of Technology,
Hoboken, New Jersey

NEWS and Notes

Edward C. Creutz, head of the Physics Department at Carnegie Institute of Technology, has been appointed director of the Carnegie Nuclear Research Center at Saxonburg, Pennsylvania. The recently established center houses the institute's 400-Mev synchrocyclotron, which is expected to go into operation next spring.

George B. Cressey, of Syracuse University's Department of Geography, is visiting Latin America on behalf of the International Geographical Union, of which he is president. He will return by mid-February. The trip, which is partly financed by Unesco, is taking him to 13 countries.

Lincoln R. Thiesmeyer has resigned as executive assistant to the director of Brookhaven National Laboratory to become president of the Canadian Pulp and Paper Research Corporation. A program to intensify scientific research and training in engineering and chemistry is planned, under the joint sponsorship of the corporation, McGill University, and the Dominion government.

Ernest R. Kaswell, associate director of research at Fabric Research Laboratories, Inc., Boston, has been elected a Fellow of the Textile Institute of Great Britain. Mr. Kaswell received the award in recognition of his research in the low temperature characteristics of textile materials and the stripping of colors from wool to permit its re-use.

H. E. King, formerly senior research scientist at the New York State Psychiatric Institute, and **Kathleen M. Young**, formerly psychologist for the Children's Group, Rockland State Hospital, New York, have both received appointments as assistant professor of psychiatry at the Tulane University School of Medicine and as visiting scientist at the Charity Hospital of Louisiana. Dr. King will conduct research in psychopathology and human brain function; Dr. Young will be in charge of all clinical psychological services of the Tulane Psychiatric Clinic.

Helen Dodson has been appointed associate professor of astronomy at the University of Michigan, effective July 1. At that time she will conclude her present part-time appointment with Goucher College at Baltimore and devote full time to the solar research she has been doing at the McMath Hulbert Observatory at Lake Angelus.

Carl L. Larson, assistant chief of the Laboratory of Infectious Diseases, National Institutes of Health, Bethesda, Maryland, has been appointed head of the Rocky Mountain Laboratory, Hamilton, Montana. Dr. Larson succeeds the late **Ralph R. Parker.**

Roy L. Lovvorn, professor of agronomy at North Carolina State College, and agent, Division of Forage Crops and Diseases, U. S. Department of Agriculture, has been named head of the recently created Division of Weed Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, at Beltsville, Maryland. He will assume his new duties January 16.

Two new staff appointments in the State University of Iowa's College of Medicine are **James W. Culbertson**, of the Boston University of Medicine, who has been appointed assistant professor of internal medicine and director of the Laboratory for Cardiovascular Research, and **Paul M. Seebohm**, who will be an associate in the Department of Internal Medicine and will also direct the Allergy Clinic at the university hospitals.

Nicholas E. Golovin has been appointed assistant to the director of the National Bureau of Standards. Prior to joining the bureau in April of this year, Mr. Golovin headed the Management Division on the Staff of the Commander, Naval Ordnance Test Station, Inyokern, California.

Visitors to U. S.

G. E. André and **C. C. Tavernier**, of the Union Minière, Brussels, Belgium; **Peter Baertschi**, of the Institute of Physical Chemistry, University of Basel, Switzerland, who is at present at the University of Chicago; **André Giraud**, chemical engineer, Direction des Carburants, Paris; **Hans G. Lind**, head of the Testing Laboratory, Aktiebolaget Nyborgs Yllefabrik, Norrkoping, Sweden; and **Olle Svensson**, honorary fellow of the American-Scandinavian Foundation, and representing the AB Bofors Nobelkrut, Bofors, Sweden, recently visited the National Bureau of Standards.

Leone Lattes, chairman of the Department of Medical Jurisprudence at the University of Pavia, Italy, will present four lectures on legal medicine in Chicago December 5, 7, 8, and 10. The first three will be held at the Chicago Medical School, the fourth at Mount Sinai Hospital. All lectures will begin at 12: 30 p.m.

Grants and Awards

Grants-in-aid totaling $100,000 for unrestricted use in fundamental chemical research have been authorized for the second year by the Du Pont Company. Institutions to receive $10,000 each for 1950–51 are California Institute of Technology, Cornell University, Harvard University, Massachusetts Institute of Technology, Ohio State University, Princeton University, Yale University, University of Illinois, University of Minnesota, and the University of Wisconsin. All of the schools received similar awards from the company last year when the plan was inaugurated on a trial basis with the aim of increasing fundamental research in this country.

Sharp and Dohme, Inc., of Philadelphia, has awarded research grants to Samuel L. Meyer and Lowell F. Bailey, of the Department of Botany, University of Tennessee, and H. Brieger, of Jefferson Medical College, Philadelphia. The grant to Dr. Meyer and Prof. Bailey is in support of their investigation on antiseptics.

Dr. Brieger's grant is for clinical studies on tetraethylthiuram disulfide.

The Rumford Medal of the American Academy of Arts and Sciences was presented to Ira S. Bowen, director of the Mt. Wilson and Palomar Observatories. Dr. Bowen received the medal for his work in spectroscopy, and particularly for his explanation of the spectral lines of nebulium.

The first Harold DeWitt Smith Memorial Medal will be presented to Herbert F. Schiefer, of the National Bureau of Standards' textile laboratory, at the spring meeting of the American Society for Testing Materials. Dr. Schiefer will receive the award in recognition of his work in the utilization of textile fibers.

The DuPont Company, of Wilmington, Delaware, has announced the award of 76 postgraduate and postdoctoral fellowships, amounting to $224,000, to 47 universities for the 1950–51 academic year. Of the 70 postgraduate fellowships, 45 are in chemistry, 15 in chemical engineering, 5 in mechanical engineering, 3 in physics, and 2 in metallurgy. The 6 postdoctoral fellowships are for work in chemistry.

The Medical Library Association scholarships for 1949–50 have been granted to three foreign medical librarians. The recipients are *Erica Emma Johannsen Oehrens*, assistant librarian at United Nations Economic Commission for Latin America, Santiago, Chile; *Ileana Ines Johannsen Oehrens*, assistant in the School of Health Library, University of Chile; and *Juan Carlos Secondi*, medical student and a graduate of the Library School, University of Montevideo.

Fellowships

A graduate fellowship in geophysical engineering has been established at the Colorado School of Mines by the Standard Oil Company of Texas. The fellowship provides $1,250 a year plus an additional amount for expenses incident to the program of study. It has as its objective the encouragement of graduate study in the field of petroleum exploration by geophysics.

Armour Research Foundation of Illinois Institute of Technology will offer industrial research fellowships in physics, chemistry, metallurgy, ceramics, mechanics, and electrical engineering for a 21-month period beginning in September, 1950. Awards will be made to graduates under 28 years of age who hold a B.A. from an accredited engineering or scientific school or from a liberal arts college with a major in science. Fellows will receive, in addition to full tuition, a monthly stipend of $150 during the first academic year, $275 during the summer, and $175 during the second academic year. Application forms may be obtained from the Dean of the Graduate School, Illinois Institute of Technology, and should be submitted by *March 15.*

Ten research fellowships in the fields of medicine, dentistry, and pharmacy will be awarded by the University of Illinois Graduate College, Chicago. In addition to tuition, the fellowships carry stipends of $1,800 per year for medical and dental graduates and $1,200 for pharmacy graduates. Application blanks may be obtained from the Assistant Dean, The Graduate College, University of Illinois, 808 South Wood Street, Chicago 12.

A research fellowship for the study of triglyceride fats and oils has been established at the **University of Pittsburgh** by Armour and Company. It will provide an allotment of $2,500 yearly for a period of three years. The fellowship, which will be used by a graduate student to be selected later, is under the direction of Bernard F. Daubert, research professor and administrator in the university's Chemistry Department.

The Illinois Institute of Technology is accepting applications for the 1950 Westinghouse Fellowship in power systems engineering, consisting of $1,500 and tuition for three semesters of full-time training leading to an M.S. degree in electrical engineering. Candidates must have a bachelor's degree in electrical engineering from an accredited engineering college. Term of fellowship will begin September, 1950. Applications must be received by *March 15.* The winner will be announced April 1. Further information and application blanks may be obtained from the Dean of the Graduate School, Illinois Institute of Technology, Chicago 16.

Colleges and Universities

The Arctic Institute of North America has established an office at **The Johns Hopkins University** which will coordinate the institute's existing arctic research projects and originate new ones. This is the second arctic research project to become associated with Johns Hopkins (see *Science*, December 9, page 647).

M. C. Shelesnyak will head the office, with headquarters in the Isaiah Bowman School of Geography. He was one of the original fellows of the institute and more recently was head of the Ecology Branch of the Office of Naval Research. He has also been appointed lecturer in ecology at Johns Hopkins.

The institute staff will work closely with the Bowman School of Geography, the Walter Hines Page School of International Relations, and other related scientific departments at Johns Hopkins. Other institute offices are at McGill University in Montreal and at the American Geographical Society in New York City.

A course in International Economic Cooperation has been established at **New York University** through a gift of $5,000 donated by the Netherlands American Foundation and the Belgian American Educational Foundation, Inc. Dr. Jan Goris, Commissioner of Information for Belgium in the U. S., will direct the new course. It is entitled "Experiments in International Economic Cooperation with Special Reference to the Benelux," and will be a two-year course.

Industrial Laboratories

Lever Brothers Company, New York City, recently announced three new appointments: *Marvin J. Hall*, director of the central laboratories of the Kraft Foods Company, as associate director of research; *Cheves T. Walling*, former member of the staff of the general laboratories of the U. S. Rubber Company, as chief supervisor of organic research; and *Leonard J. Vinson*, supervisor of research on biochemical problems at the Armour Research Foundation, Chicago, as chief supervisor of biological research in Lever's Basic Laboratories Division. Until the completion of the company's new research center at Edgewater, New Jersey, the new members of the staff will be located at the present headquarters in Cambridge, Massachusetts.

Cuthbert C. Hurd, former research head at Oak Ridge, Tennessee, has been named director of the Applied Science Department at **International Business Machines Corporation**, New York City. At Oak Ridge, Dr. Hurd was also chairman of a committee on technical calculation procedures at the Gaseous Diffusion Plant.

A gift of $30,000, to be used for the establishment of a pharmacy, has been presented by the **A. H. Robins Company** to the Richmond Memorial Hospital fund. The 321-bed hospital, which will be located in a part of Richmond not now served by a hospital, was proposed as the result of a survey of the city's hospital needs conducted by Robin C. Buerki, of the University of Pennsylvania.

Meetings and Elections

Industrial and Safety Problems of Nuclear Technology will be the subject of a three-day conference beginning January 10, to be held by New York University in cooperation with the U. S. Atomic Energy Commission. The purpose of the conference, which will take place at the General Electric Auditorium, New York City, is to encourage a wider and safer use of radioactive materials. It is sponsored by the Division of General Education and the Center for Safety Education of New York University.

The National Speleological Society will meet January 14 at the Philadelphia Academy of Natural Sciences, Philadelphia. Inquiries should be addressed to Mrs. Ellen Moffett, Secretary, 2702 Wisconsin Avenue, N.W., Washington, D. C. Dates for the first international congress of speleological societies have been set for May 27–30. The congress will be in Monterrey, Mexico.

The Division of High Polymer Physics of the American Physical Society will hold its 7th meeting in New York City, February 2–4. Most sessions will take place at the Polytechnic Institute of Brooklyn. A feature of the meeting is a symposium on stress phenomena from the viewpoint of solid state and high polymer physics, to be presented at Columbia University on February 3.

U. S. scientists who have been invited to attend the symposium "**La Structure et la Physiologie des Sociétés Animales,**" to be held in Paris March 19–25, are W. C. Allee, Department of Zoology, University of Chicago; C. R. Carpenter, Department of Psychology, Pennsylvania State College; A. E. Emerson, Department of Zoology, University of Chicago; and T. G. Schneirla, American Museum of Natural History, New York City.

Officers elected for 1950 at a three-society meeting in Memphis, Tennessee, last month are: **American Society of Tropical Medicine**: president elect, Paul F. Russell, Rockefeller Foundation, New York City; vice president, F. J. Brady, U. S. Public Health Service, Bethesda, Maryland; and secretary-treasurer, Quentin Geiman, Harvard University, Boston. **American Academy of Tropical Medicine**: president, E. C. Faust, Tulane University, New Orleans; vice president, Fred L. Soper, Pan American Sanitary Bureau, Washington, D. C.; Clay G. Huff, Naval Medical Research Institute, USN Medical Center, Bethesda; treasurer, H. E. Meleney, New York University School of Medicine. **National Malaria Society**: president, Paul F. Russell, Rockefeller Foundation; president elect, Justin M. Andrews, U. S. Public Health Service, Atlanta, Georgia; vice president, W. H. W. Komp, U. S. Public Health Service, Bethesda, Maryland; secretary-treasurer, Martin D. Young, U. S. Public Health Service, Columbia, South Carolina.

The Society of American Foresters has elected Charles F. Evans, assistant regional forester for the southern region of the U. S. Forest Service, to serve as president for the two-year term 1950–51. He succeeds Clyde S. Martin, of Tacoma, Washington. Clarence S. Herr, resident woods manager of the Brown Company, Berlin, New Hampshire, was elected vice president.

Deaths

William J. Bonisteel, botanist, died December 12 in Mexico City of a cerebral hemorrhage. He was 57 years old. Dr. Bonisteel was research director of Cia Minera Sta. Lucia, S. A., Mexico, and had been doing research in plant breeding and rare earth minerals in Mexico.

John Stanley Coulter, chairman of the Department of Physical Medicine at Northwest University Medical School, died at his home in Westville, Indiana at the age of 64. Dr. Coulter was an authority on rehabilitation and in 1943 received the Gold Key Award of the American Congress of Physical Medicine.

Atomic Energy Commission laboratories issued 57 declassified and unclassified reports last month in the fields of biology and medicine, chemistry, engineering, mineralogy, metallurgy and ceramics, and physics. Subjects reported on include the effect of low dosages of radiation upon blood counts of individuals exposed to ionizing radiation; a leak detection method in industrial chemical processing systems, originally developed at the University of California's Radiation Laboratory in 1943; a low cost production method for industrial fluorine; and the latest results in the measurement of the heat of vaporization and vapor pressure of graphite. A complete list of the reports and information on how to get any of them may be obtained from the Document Sales Agency, Atomic Energy Commission, Box E, Oak Ridge, Tennessee.

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